THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY

OF

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SECOND SERIES—VOLUME I.

BOTANY.

LONDON:

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MISSOURI

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ERRATA.

Page 94, line 3 from bottom, for " *Pirigara* " read Perigara.
115, line 4 „ " *Butonica rotata* " read *Butonica rosata.*
124, line 21 from top, for " A. cinerascens " read P. cinerascens.
287, by inadvertence of printer, is made " 728."
444, line 18 from top, omit " *Cystopteris dimidiata*, Dcne. in Jacquem. Voy. Bot. t. 178," which is rightly referred to Davallia bullata in p. 445.
446, line 13 from bottom, in " serratures " a letter has accidentally dropped out.
504, top line, " *Hemedictyum* " should be *Hemidictyum.*
512, bottom line, for " F. cuspidatum " read N. cuspidatum.'
568, line 18 from top, for " *C. Totta* " read *G. Totta.*

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M.DCCC.LXXV.

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(Plates I.–IV.)

Read June 4th, 1874.

The plants arranged in the small group of the *Napoleoneæ* consist of two heterogeneous genera, the position of which in the system has long been a puzzle to botanists. One of them is of African, the other of Brazilian origin. The former, *Napoleona*, was established by Palisot de Beauvais for a beautiful species discovered by him in 1787, at which time his drawing and description were made, though not published till 1804[1]. *Asteranthos*, at first thought to have been brought from Africa, was afterwards found to be of South-American growth. Desfontaines, who first described and figured the latter in 1820[2], considered that the two genera should constitute a group belonging to *Symplocineæ*. Desvaux changed the name *Napoleona* into *Belvisia*, in honour of Palisot de Beauvais[3]. Desfontaines subsequently, as well as Brongniart, placed this group between *Memecylaceæ* and *Rhizophoraceæ*. Brown, in 1822[4], proposed it as a distinct family (*Belvisieæ*), to stand near *Symplocaceæ*, with a tendency towards *Rafflesiaceæ*. Lindley in 1833[5], and again in 1836[6], placed *Belvisiaceæ* after *Campanulaceæ* and *Sphenocleniaceæ*, and before *Columelliaceæ*; but in 1845[7] he changed this view, arranging it between *Rhizophoraceæ* and *Melastomaceæ*. De Candolle, in 1839[8], located the *Napoleoneæ* after *Sphenocleneæ* and *Columelliaceæ*, and before *Vaccinieæ*. Endlicher, in 1839[9], regarded the *Napoleoneæ* as doubtful genera of the *Ebenaceæ*; he arranged them provisionally between *Symploceæ* and *Columelliaceæ*. Meissner, in 1843[10], placed the *Belvisieæ* between *Passifloreæ* and *Loasaceæ*. Jussieu, in 1844[11], in describing a second species of *Napoleona*, placed this

[1] Fl. Owar. ii. 32, tab. 68. [2] Mém. Mus. vi. 9, tab. 3. [3] Journ. de Bot. appl. iv. 130. [4] Linn. Trans. xiii. 222. [5] Nixus and Introd. Bot. p. 230. [6] Nat. Syst. p. 239. [7] Veg. King. p. 728. [8] Prodr. vii. 550. [9] Gen. Pl. p. 745. [10] Gen. Pl. [11] Ann. Sc. Nat. 3me sér. ii. 227, tab. 4.

group between *Cucurbitaceæ* and *Passifloreæ.* Lindley, in 1845, described and figured a third species of *Napoleona*, collected by Whitfield in Sierra Leone[1]. Sir Wm. Hooker and Dr. Planchon, in 1848[2], first suggested that the *Napoleoneæ* approached nearer to *Myrtaceæ,* as shown by the relation of *Napoleona* to *Gustavia* in *Lecythidaceæ*, and to *Luffa* in *Cucurbitaceæ*; but they offered no evidence in support of so novel a view. Mr. Bentham[3], in 1849, adopted the same opinion, making the *Napoleoneæ* a suborder of *Myrtaceæ,* allied to *Barringtonieæ,* on account of its numerous stamens seated upon a disk over an inferior ovary. Agardh, in 1859[4], attempted to show that the *Napoleoneæ* are allied to *Ternstrœmiaceæ.* Messrs. Hooker and Bentham in 1867[5], maintaining their former views, arranged the *Napoleoneæ* as a third subtribe of their *Lecythideæ,* which is their fourth tribe of their *Myrtaceæ,* thus associating it intimately with *Barringtonieæ* and *Lecythideæ* proper. Finally, Dr. Masters, in 1868[6], contributed a valuable memoir on *Napoleona,* drawn up from his examination of a flowering species growing at Kew. Its structure is there minutely described; but he offered no opinion of the true affinity of the group, except in accepting the view of Bentham and Hooker, and in concluding that the *Myrtaceæ* is its more fitting resting-place.

We may attribute this extraordinary divergence in the opinions of botanists entirely to the confused notions entertained about the several floral parts, which had been regarded as modified petals by some, as a kind of compound paracorolla by many, while others have considered these parts transformed stamens, or nectariferous emanations from a disk, or coronal appendages analogous to those of *Passiflora.* A very careful examination of these two genera has convinced me that all have been wide of the mark in regard to their true affinity. In order, therefore, to arrive at a proper conclusion, it is desirable to scrutinize the floral and carpological structure with greater circumspection than has hitherto been employed.

1. Napoleona.

In conducting this analysis, it appeared to me that the first essential condition was to separate the different parts from one another. With this view, after moistening a dried flower, a knife was carefully introduced beneath the corolla, so as to cut off its connexion with the disk, which supports all the floral parts; the sepals and ovary were thus set free. The corolla was then carefully detached from the corona in the same manner. This, in the bud state, is plicated and incurved, so as to form a depressed globe; but when fully developed, and thus separated, it is seen to be gamopetalous, petaloid, orbicular, quite rotate, marked beneath by several subulate flat subprominent radiating nerves, connivent at the base, varying in the several species from 30 to 40 (the intermediate spaces being membranaceous); and they terminate in as many short obtuse peripherial segments of the border.

The corona, now isolated, is seen to consist of three distinct whorls, all affixed, like the corolla, upon the outer surface of the disk. The outer whorl, now fully exposed to view, as seen from below, consists of 60 to 70 distinct, narrow, pointed segments, free to the

[1] Bot. Reg. (1844) p. 780; Gard. Chron. 1844, p. 480; Veg. Kingd. (cum icone) p. 728.

[2] Hook. Icon. vii. tab. 799.

[3] Niger Flora, p. 361, tab. 49.

[4] Theor. p. 132.

[5] Gen. Plant. i. 696.

[6] Journ. Linn. Soc. x. 492.

base, somewhat shorter than the corolla, all radiating outwards, each with a fine median nerve. In a circle, about $\frac{1}{4}$ of an inch beyond the points of their attachment, we now observe a very distinct moniliform ring of prominent vesicles, one upon each segment, bearing the appearance of as many sterile anther-cells. This important feature appears to me to afford a key to the nature of the whole structure, and seems to have been overlooked by all botanists, except perhaps by Dr. Masters[1].

The second whorl of the corona is also petaloid, formed of 40 to 60 similar but broader segments, sometimes as long as, often shorter than the corolla. These are confluent along their margins towards the base for $\frac{1}{2}$ or $\frac{3}{4}$ of their length, thus forming a cup; but the external portions are quite free, erect, or curving inwards. Looking at this cup from below, we see a similar ring of prominences as in the former case, and at the same distance from the base, all forming as many distinct hollow patches, like corrugated vesicles.

The third or internal whorl consists of a series of linear segments like the preceding, and, I believe, constantly 20 in number. They are attached to the disk in a similar manner, are quite free to their base, their margins touching or overlapping each other; they have a fine nerve along their centre up to a short distance below the apex, there terminating in a prominent point, where the anther is attached; these have been considered true filaments by all botanists. The anther is oblong, a little curved, appearing 2-lobed, owing to a deep furrow down their middle; it opens bivalvately at the bottom of the furrow, its margins becoming detached from a prominent line upon the connective; before dehiscence, they are consequently 2-locellate; after bursting they appear 1-locular; this cell is adnate for its whole length, upon a narrow fleshy connective and is affixed by one of its extremities to the point in the nerve of the filament before mentioned, always extrorsely. By the hippocrepiform curvature of the filaments the anthers become lodged in the 5 open cavities within the area of the concave disk, formed by the projecting winged angles of the style. Although there are 20 similar filaments, not more than 10 (sometimes only 5) bear anthers, the summits of the others being crumpled round the termination of their nerve. We may thus believe in the statement of Palisot on this point, which many botanists have doubted.

The disk which supports the floral parts is annular, narrow, prominently erect, crenulated on the margin, and placed around the deeply hollow vertex of the ovary, wherein the stigma is ensconced; the latter, peltately supported by a short, broadly 5-angular style, is large, depressed and pentagonal, hollow in the centre, with 5 radiating furrows on the flat summit, each terminating near the angles, in a gaping gland filled with stigmatic tissue.

The calyx consists of 5 equal, triangular sepals, which surround the disk, are valvate in æstivation, but afterwards quite rotate; they are thick, flat, with square margins, which end externally in a short mucronate point, on each side of which there is generally a distinct imbedded gland.

[1] Seeing them upon the second whorl, he says, "But just at the bend they often present a slight excrescence or fold, representing perhaps the traces of an anther" (Journ. Linn. Soc. vol. x. p. 495).

The inferior ovary is shortly turbinate, varying in the number of its cells. Beauvais figures about 20 radiating cells in his typical species. Jussieu, who reexamined the same plant, does not contradict this, but says he found four ovules in each of its cells. In *N. Heudelotii* the ovules are superposed in pairs. In *N. Whitfieldii* Dr. Lindley found the ovary to be 5-celled, with only 2 collateral ovules in each cell. In *N. Mannii* I saw several ovules in each cell superposed in pairs. One curious point of structure was noticed by Dr. Lindley in the ovary of *N. Whitfieldii* which had been preserved in spirits: the axis, round which the cells radiate, was hollow, in continuation of the hollow style; and an open foramen was seen leading out of that space into each cell, above the point of suspension of the ovules. He figures this in fig. 5 (Veg. Kingd. p. 728); and he describes, as shown in fig. 6, a depressed dark spot on each side of the ovule, which I have witnessed in another species—a circumstance to which I shall have to refer presently.

The fruit is subglobular, about the size of a small apple, deeply umbilicate at the summit, within which cavity are seen the persistent sepals, disk, style and stigma; it is indehiscent, with a coriaceous pericarp, not always very thick, and varying in the number of its cells.

The seeds are solitary, or 2 superposed in each cell, sometimes enveloped in a thin pulp, sometimes without pulp; they are obconically globose, and subangular by compression, or they are oblong, reniform, laterally compressed, exhibiting generally, in the deep ventral sinus, a broad oblong cicatrix, like that in the seeds of many *Sapotaceæ*, showing where they are agglutinated to the inner angle of the cell and to the sides of the dissepiments—an important feature not hitherto observed; the testa is thin and membranaceous, generally evanescent. The embryo consists of 2 equal fleshy plano-convex cotyledons, with a short radicle, which is hidden between them at the lateral sinus, where also a large centrifugal plumule lies concealed.

The several species described by authors are reduced to two by Messrs. Bentham and Hooker (Gen. Pl. i. p. 724), but they are amalgamated into one only by Prof. Lawson (Oliv. Afr. Fl. p. 439). It appears to me, on the other hand, from the characters given by different authorities, and from others indicated by the specimens in our herbaria, that several species may easily be recognized by the following data. The typical species comes from the kingdom of Benin, at Waree, on the river Escardos, where, in alluvial ground, it forms a small tree, 7 or 8 feet high. The species found by Heudelot in the high land of Foota Jalhoo, 1000 feet above the level of the sea, and 500 miles in the interior of the Senegal coast, is a tree with a straight trunk 25 to 33 feet high. Most of the other species grow near the sea-coast. Vogel's species has been found at the two extremities of the Gold Coast, at Cape Palmas, by Vogel, and at Lagos by Baxter. Whitfield's specimens were found by him at Sierra Leone and the river Nuñez, where it forms a shrub with the appearance of a *Camellia*, 5 to 7 feet in height. Mann's plant from Fernando Po is a tree 20 to 25 feet high. Mann's specimens from Old Calabar are very different, and form a smaller tree, only 10 to 15 feet high. Welwitsch states that his plants from the interior of Angola were obtained from a tree with a simple straight trunk, 12 feet high.

The leaves in Beauvais's plant are oblong, constricted at the summit into an obtusely

narrow acumen, at the bottom of which, on each side, is a broad tooth; they are acute and biglandular at the base, upon a very short petiole. In Heudelot's specimens they are narrower, subacute at the base, terminate at the summit in a simple narrow obtuse point, and they have a slender petiole. In Vogel's specimens they are more elliptic, with a narrow mucronate acumen, are more coriaceous, with undulating cartilaginous margins, where several dark spots are seen, indicating as many abortive teeth; they are pale above, yellowish beneath, biglandular near the short fuscous petiole, and have about 9 pairs of ascending nerves. In Whitfield's numerous specimens the leaves are longer, with a long, narrow acumen, are of a darkish green colour above, and of a peculiar lurid brown beneath, are subcoriaceous, with about 8 pairs of more patent nerves, rarely with basal glands, and have longer petioles. In Mann's plant, from Old Calabar, the leaves are nearly double the size of any of the preceding, are more oblong, suddenly contracted at the apex into a very long narrow acumen, below which is seen an obtuse tooth on each side, as in Beauvais's plant, but with the addition within it of a conspicuous gland; they are acute at base, with 2 glands near a very short dark-red thicker petiole; the margins are undulated and cartilaginous; and they have ten pairs of straight ascending nerves. In Mann's plant from Fernando Po the leaves are still longer (10 inches), broader at the base, terminating abruptly at the summit in a short simple obtuse acumen; they are more coriaceous, very pale, with an almost encaustic surface above, pale yellow, and subnitid beneath, rarely with basal glands, with 12 pairs of prominent diverging nerves, and short stiff fuscous petioles. In Welwitsch's plant from Angola the leaves are of median size, much more membranaceous, more elliptic, of a more opaque green on both sides, obtusely and distinctly toothed on their thin margins, without basal glands, with about 7 pairs of subascending nerves, have extremely short petioles, with their margins subdecurrent with the angles of the branches.

This constant difference in the leaves and habits of the plants is accompanied by equally marked peculiarities in the flowers and fruits, indicating the distinctness of the species. In the flowers the number of sepals is constantly 5 (except where, as rarely happens, they are reduced to four by abortion); the number of marginal lobes and rays of the corolla, the number of segments in the several whorls of the corona, vary in the several species, but they are always multiples of 5. The following table gives in columns the number of parts in the several whorls of the flower, and the relative dimensions of the calyx and corolla in the several species:—

Species.	Lobes and ribs of corolla.	Corona.				Relative diam. of calyx and corolla in lines.	
		Outer whorl.	Second whorl.	Inner whorl of filaments.	Anthers.	Calyx.	Corolla.
N. imperialis	35	35	35	20	10	8	18
N. Heudelotii........	40	40		20	10	7	15
N. Vogelii	30	75	40	20	5	8	20
N. Whitfieldii	35	60	50	20	5	9	18
N. cuspidata	40	70	40	20		10	21
N. Mannii	30	40	40	20		11	13
N. angolensis	30	60	45	20	10	12	21

Those botanists who have advocated the amalgamation of the species, place little reliance on the colour of the flowers, which they say is variable; but Beauvais, Jussieu, Whitfield, and Welwitsch assert that the colours are constant; and this appears confirmed by the dried specimens. In *Napoleona imperialis* the corolla is of a beautiful ultramarine blue, the corona of a roseate colour. In *N. Heudelotii* the corolla is of a reddish purple, the corona of a pale rose-colour. In *N. Vogelii* the corolla is yellow, with a tinge of red about the base, the corona being yellowish white. In *N. Whitfieldii* the corolla is of a uniform apricot-colour for more than half its length, then suddenly red towards the base, the corona is yellow, the filaments of a rich crimson colour. In *N. Mannii* the corolla is only half the usual size; this, as well as the corona, is of a pale yellow, the filaments quite white. In *N. cuspidata* the corolla in the dried state appears of the same colours as in *N. Whitfieldii*, but the corona is of a deeper roseate hue. In *N. angolensis* the corolla is white, the corona is white, but the campanular base of the 2nd whorl is of a violet apricot-colour, and the staminal whorl of the same hue.

The fruit varies in size in the several species. In *N. imperialis* it is said to be spherical, with a softish pericarp about the size of a small apple, with many seeds imbedded in fleshy pulp. In *N. Heudelotii* it is figured as spherical, has a soft coriaceous pericarp 1 or 2 lines in thickness, with 5 thin persistent dissepiments, each cell containing 4 seeds in superposed pairs, of a shape very different from all others. In *N. Vogelii* the fruit is globular, somewhat depressed, obsoletely 5-lobed in the periphery; the pericarp is $2\frac{1}{4}$ inches in diameter, and $1\frac{1}{2}$ line in thickness, externally of a dark maroon colour, with pale spots, is about 10-celled, contains about 12 seeds, some of them slantingly superposed; and there is no appearance of pulp in the specimen preserved in spirits. In *N. Whitfieldii* the fruit is $2\frac{1}{2}$ in. in diameter, of a more depressed globular form, with a pericarp not thicker than a common card, of a pale rose-colour, with white spots, is very brittle when dry: it has apparently been 5-celled; but no remains of dissepiments were visible in the specimen in the British Museum. Whitfield says that the seeds are enveloped in an edible pulp. In *N. angolensis* the fruit much resembles that of the preceding in size and colour, but the pericarp is somewhat stouter, more firm, obsoletely 5-lobed on the periphery; in the dry state it seems to have been 5-celled, and the seeds have probably been enveloped in pulp.

These many differential characters, though long disregarded, are positive, and fully justify the maintenance of several good species. Up to 1845, indeed, three of them were acknowledged, when in that year Dr. Lindley proposed a fourth, upon Whitfield's specimens. In 1848, however, Sir Wm. Hooker, in figuring and describing the latter from a living plant, pronounced decidedly that it did not differ specifically from the original species, *N. imperialis*, or from Heudelot's plant; for he could discern no dissimilarity between the three plants, except that of colour, which was due solely to their fading in drying. This broad assertion so puzzled Van Houtte, that he wrote immediately to Prof. Decaisne, asking him to examine the typical specimens of Beauvais and Heudelot's plants in the Paris collections, in order to determine this point. The learned Professor [1]

[1] Flore des Serres, vol. iv., sub tab. 386, 387 (1848).

replied, that he had done so, and could not understand upon what ground the conviction of Sir Wm. Hooker rested, as the latter had evidently forgotten that the plants of the two French botanists were examined by them in their growing state, in localities far apart, the blue colour of the one and the purple of the other being noted by them on the spot (and not in the dried state), specifying the time of year they were thus seen in flower. M. Decaisne added that Sir Wm. had failed to notice several facts, such as the peculiar glands in the plants, the difference in the size of the fruits, the great dissimilarity in the seeds, the comparative size of the plants, and other characters; he concluded that, until he saw proof to the contrary, he should continue to regard Heudelot's plant as a species widely different from Whitfield's. He could not speak with equal certainty in regard to *N. imperialis* and *N. Heudelotii*; but Jussieu, in comparing these two plants, speaks decisively on this point[1], stating that their differences are so great that it is impossible to mistake one for the other. In the following year (1849) Mr. Bentham supported the view of Sir Wm. Hooker, and even went so far as to include *N. Vogelii* in the same category, thus amalgamating the four species into a single one, *N. imperialis*[2]; but in 1865 he somewhat modified this opinion by admitting the existence of two species[3]. Prof. Lawson afterwards reduced all the plants of *Napoleona* to a single species[4]. Since that time little fresh evidence has been offered on the subject, except the valuable information contributed by Dr. Masters in his excellent analysis of the living flower of Whitfield's plant[5], when he compared this evidence with the published details of other botanists. He pointed out many of the notable differences I have enumerated in the preceding pages, not only in regard to the flowers, but dissimilitude in the habit, in the leaves, fruit, and seeds; still he drew no inferences from them as applicable to the determination of the species; on the contrary, he says, "Whether all these plants belong to one variable species, or whether there are four or five distinct forms, is a question no one can answer at present"[6]. Notwithstanding this, as the differences are so many, so well marked, and so constant, I have ventured to employ them in the maintenance of the following species:—

1. Napoleona imperialis, Pal. Beauv. (non Hook.) Fl. Owar. ii. p. 32, tab. 78; DC. Prodr. vii. p. 530; Lam. Encl. Suppl. iv. p. 57; Dict. Sc. Nat. tab. 66; Reich. Exot. Bot. tab. 137; Sertum Bot. (Brux. 1828), tab. 4.; Van Houtte, Flor. des Serres, i. p. 1, tab. 1; Walp. Bot. Reg. vi. p. 408: arbuscula, ramulis tenuiter teretibus, glabris: foliis oblongo-ovatis, apice repente constrictis, et in acumen lineare obtusulum productis atque hic utroque latere dente obtuso munitis, cæteroquin integris, marginibus cartilagineis, supra viridibus, costa plana, nervis divergentibus utrinque 7, subtus fuscioribus, costa nervisque flavidis prominentibus, imo 2-glandulosis, petiolo limbo 30–35plo breviore: floribus axillaribus, 2–3, fasciculatis, sessilibus, quorum unico simul expanso cum 2 alabastris imo pluribracteolatis, bracteolis rotundatis; sepalis 5, acutis, apice extus 2-glandulosis; corolla orbiculata, rotata,

[1] Ann. Sc. Nat. 2me sér. ii. 226.
[2] Niger Flora, p. 361.
[3] Benth. & Hook. Gen. Pl. i. p. 724.
[4] Oliver's Afr. Flor. p. 489.
[5] Proc. Linn. Soc. x. p. 492.
[6] *Loc. cit.* p. 494.

pulchre azurea, rotata, margine crenulato, subtus nervis crassis subulatis radiantibus 35 donata; corona rosea, paulo minore, verticillo primo e segmentis 35 linearibus rotatis liberis, verticillo secundo e segmentis 35 linearibus imo in cupulam connatis, superne liberis, et centrum versus inflexis, verticillo interiore e filamentis 20 liberis, plano-linearibus, crebre uniseriatis, inflexis, quorum 5 antheriferis; pistillo generis: drupa globosa, apice umbilicata, sepalis stigmateque coronata, pluriloculari, plurisperma, seminibus in pulpa nidulantibus. In regione Benin, ad Waree: *v. s. in herb. Hook.* (*Beauvais*).

The above details are derived from the description of Beauvais, and from the incomplete specimen at Kew sent from the Paris Museum. The species is abundant in woods behind the royal residence on the river Escardos, growing to the height of 7 or 8 feet. The leaves are 4½–6 in. long, 2–2¾ in. broad, on a petiole 2 lines long: the calyx expanded is 8 lines in diam.; the corolla is 18 lines in diameter.

2. Napoleona Heudelotii, Juss. Ann. Sc. Nat. 2me sér. ii. 227, tab. 4; Fl. des Serr. i. p. 2, tab. 2; Ann. Hort. (1822) tab. 10; Walp. Rep. vi. 408: *Napoleona imperialis*, var. *purpurea*, DC. Prodr. vii. 750: arbor ramis verticillatim horizontalibus, ramulis subtenuiter teretibus, subangulatis, brunneis, striolatis: foliis oblongo-ellipticis, imo subacutis, apice in acumen breve obtusulum sensim aut repente constrictis, margine integris, tenuiter chartaceis, utrinque pallide viridibus, opacis, et minute granulatis, subtus vix obscurioribus, nervis tenuibus supra immersis, subtus nervis pallidis venisque prominentibus, imo 2-glandulosis, petiolo fusco limbo 20plo breviore: inflorescentia præcedentis; corolla ejusdem formæ sed purpurea, margine crenata, nervis subulatis 40 radiantibus; corona rosea, verticillo exteriore e segmentis linearibus liberis 40 nervis corollæ alternis, verticillo 2do imo poculiformi, margine in lacinias 40 incurvas fisso; filamentis 20, antheris 10; stylo et stigmate generis; ovario infero, 5-loculari, ovulis in quoque loculo 4, collateraliter superpositis: drupa globosa, ambitu obsolete 5-loba, 5-loculari; seminibus in quoque loculo 4, superpositis et collateralibus, pulpa involutis, angulato-globosis, lateribus compressis, apice subcuneatis, emarginatis, et hinc ad axem affixis, testa tenui; cotyledonibus plano-convexiusculis, crassis, carnosis; radicula in sinu immersa, ad axem spectante. In Senegambia interiore: *v. s. in hb. Mus. Brit. et Hook.* Foota Jalhoo (*Heudelot*).

The Museum specimen was sent by Jussieu to Mr. Robert Brown, the other one to Kew, from the Paris collection, both collected by Heudelot under the circumstances mentioned in a preceding page. It forms a tree, which is rare, with a straight trunk about 30 feet high, growing in freshwater places on the elevated tableland of Foota Jalhoo, in ferruginous rocks. The axils of its slender branchlets are ¾–1 in. apart; the leaves are 3½–5½ in. long, 1¼–2 in. broad, on petioles 2 lines long: of the three axillary buds, only a single flower is developed at the same time. The corolla, of a reddish purple colour, is 1¼ in. in diameter; the corona, of a rose-colour, is half that diameter. The drupe, marked with white spots, is 1¾ in. in diameter, 1½ in. high, the coriaceous pericarp being 1½–2 lines thick; it is 5-celled, containing 20 superposed seeds, which are 6–8 lines in

thickness, roundish, somewhat flattened on the sides by pressure, a little narrowed towards the point of their attachment at the axis, near which the radicle is embedded in the very fleshy cotyledons.

3. Napoleona Vogelii, Hook. et Planch. in Hook. Icon. tab. 799; Benth. in Niger Flora, p. 360, tab. 49; Walp. Ann. i. p. 475: ramulis tenuibus, pallide brunneis, sulcatis; foliis ellipticis, imo acutis, apice in acumen longum angustum sæpe callosum repente constrictis, subundulatis, ad marginem cartilagineum punctis fuscis obsolete serratis, chartaceis, supra pallide viridibus, opacis, nervis tenuibus semi-immersis, subtus fulvescentibus, opacis, nervis venisque prominentibus; sub lente crebre impresso-punctulatis, imo petiolum versus biglandulosis; petiolo tenui, fusco, subtus corruguloso, limbo 18plo breviore: inflorescentia consueta; sepalis 5, rarius 4, apice biglandulosis; corolla orbiculata, depresse concava, pro dimidia parte externa flava, interne sensim rubra, nervis 30 acute lanceolatis radiantibus extus granulato-pruinosis munita; coronæ flavidæ verticillo 1° e segmentis 75, anguste linearibus, liberis, radiantibus, verticillo 2° e segmentis 40 linearibus, pro dimidia parte in cupulam coalitis, marginem versus liberis et incurvatis; filamentis 20, consuetudine liberis et incurvis, antheris fuscis 10; ovario pluriloculari, ovulis perplurimis superpositis: fructu depresse subgloboso, ambitu obsolete 5-lobo, calyce coronato, fusco-purpureo, flavide maculato, 7–11-loculari; seminibus 12 vel pluribus in loculis solitariis, vel oblique superpositis, axi affixis, oblongis, compressis, ventre reniformi-sinuatis. In Africa occidentali: *v. pl. s. in hb. Hook.* Cape Palmas (*Vogel*), Lagos (*Baxter*, 20144); *v. fr. in Mus. Kew. in spiritu* (*Vogel*), *siccum* Sierra Leone (*Lee*).

Baxter's plant may prove to be distinct; but as it greatly resembles Vogel's in its characters, I have considered it identical. The acumen in the leaves of the former is longer and narrower, the leaves are longer and more acute at the base; and the two come from localities widely apart. The leaves are 3½–4 in. (in Baxter's 5 in.) long, 1½–2 in. broad, on petioles 1½–2 lines long. The corolla is 20 lin. in diam.; when not expanded, and only half that size, it is of a pale yellow colour; when full-grown it is a bright red colour towards the base. The fruit is 2¼ in. in diam., 2 in. high, and is well represented in Hook. Icon., though somewhat larger than the specimens; there is no appearance of pulp, either when preserved in spirits or when dry; the dissepiments are more persistent than in any other species, where they are probably membranaceous and disappear with the pulp.

4. Napoleona Whitfieldii, Lindl. Gard. Chron. 1844, p. 780; Bot. Reg. vol. xxx. Misc. p. 77; Veg. Kingd. p. 728 cum icone; Van Houtte, Fl. des Serres, tab. 386, 387; Decaisne, Rev. Hort. (1853), p. 301, tab. 16; Schnizl. Iconog. ii. tab. 159. fig. 1 ad 8: *Napoleona imperialis*, Hook. (non Palis.), Bot. Mag. tab. 4387: ramulis verticillatis, patentissimis, pallide brunneis, rugulosis: foliis oblongo-ellipticis, imo subacutis, apice in acumen lineare obtusulum constrictis, integris, marginibus subcartilagineis, rigidule chartaceis, supra pallidissimis, sæpe encausto-canescentibus, valde opacis, nervis paullo prominulis, subtus obscurioribus, brunnescentibus, opacis,

sub lente scabridule lepidotis et punctulatis, costa pallida nervisque prominulis, ad basin rarius 2-glandulosis; petiolo fusco, canaliculato, limbo 16plo breviore: floribus axillaribus generis; corolla rotata, subconcava, peripherio armeniaca, centro coccinea, subtus costis planatis 35 viridescentibus et scabridulis sensim acutis, margine in lobulos totidem crebre plicatulos incisa; coronæ coccineæ series externa e segmentis 60 liberis anguste linearibus constat, series intermedia e segmentis 50 linearibus ad medium campanulatim coalitis apice liberis et incurvatis, series interna e filamentis 20 linearibus introflexis, imo in annulum brevissimum connatis, et hic ad discum elevatum crenulatum affixis; antheris 10; ovario 5-loculari, ovulis 4–6 in quoque loculo collateraliter axi superfixis: drupa depresse globosa, pallide rosea, albide maculata, 5-loculari, pericarpio tenuissimo fragili; seminibus paucis, oblongis, compressis, ventre reniformibus, in pulpa mucilaginosa eduli immersis. In Africa tropica: *v. s. pl. in herb. Mus. Brit.* Sierra Leone (*Whitfield*), Sierra Leone (*Afzelius*); *in hb. Hook.* Sierra Leone et Rio Nuñez (*Whitfield*): *v. fr. s. in Mus. Brit.* (*Whitfield*).

Whitfield described this plant as like a camellia-bush; and Lindley says it has a softish wood remarkable for its large medullary rays, with abundance of spotted vessels intermingled with acicular tubes of woody tissue, like those found in the germinating radicle of *Rhizophora*. In Whitfield's specimen from Rio Nuñez, the branchlets spread at right angles; and Sir Wm. Hooker figures them as verticillated and horizontal. The axils generally are $\frac{3}{4}$–$1\frac{1}{2}$ in. apart; the leaves are $4\frac{1}{2}$–$6\frac{1}{2}$ in. long, $1\frac{3}{4}$–$2\frac{1}{4}$ in. broad, on petioles 3–4 lines long, near which below a gland is seen on each side; they are furnished with about 8 pairs of divergent nerves. The inflorescence, as in most of the other species, consists of 3 fasciculated flowers, almost sessile, on extremely short pedicels, which bear 4 small roundish decussately imbricated bracts, each 2-glandular. Of these 3 flowers only one is at first developed, the other two in the meanwhile remaining in the bud-state: the sepals are square on the edges, gradually narrowing into a wedge-shaped point, below which externally are 2 imbedded glands; they are 3 lines long, 3 lines broad at the base, and are marked outside with many yellowish prominent granules; they spread rotately to a diameter of 9 lines on the summit of the inferior turbinate ovary. The corolla is $1\frac{1}{2}$ in. in diameter. The fruit is $2\frac{1}{2}$ in. broad, $1\frac{1}{2}$ in. high, crowned by the persistent calyx and stigma, and there umbilicated; it differs from all other species in its pericarp not being thicker than a thin card, in being very brittle; it shows internally the slight vestiges of 5 dissepiments, which would seem to have been membranaceous; for no traces of them are seen in the dried fruit, nor of the edible mucilaginous pulp in which the seeds are said to be enveloped. There are about 12 seeds, laterally compressed, 12 lines long, 7 lines broad, and $4\frac{1}{2}$ lines thick: the thin membranaceous testa decays in drying, leaving the embryo bare, except on the cicatrix on the ventral sinus, which is seen often on one side only, where the seeds have been collateral in each cell, and where they have been there attached on one side of the dissepiment.

5. Napoleona cuspidata, nob.: ramulis subvalidis, pallidis, costato-striatis: foliis majoribus, oblongis, imo obtusis aut subacutis, apice in acumen lineare longum glanduloso-mucronatum subito constrictis, marginibus undulato-crispatis, integris, sub

acumen dente magno obtuso medio subtus glandulifero utrinque munitis, subcoriaceis, pallidissimis, opacis, cum nervis tenuibus rectiuscule adscendentibus utrinque circa 10, venis transversis reticulatis, subtus fulvescentibus, subnitentibus, costa nervis venisque prominentibus, ad basin breviter revolutis et hic glandula parva notatis; petiolo semitereti, substriato, fusce rubido, limbo 60plo breviore: floribus 3, sessilibus, quorum 2 alabastris, et unico expanso, e gemma axillari imo bracteis 4 parvis rotundis decussatis biglandulosis munita ortis; sepalis 5, acutis, apice glandulis 2 signatis; corolla orbiculata, magna, extus nervis 40 lineari-lanceolatis, margine in lobos totidem breves crispatos secta, imo purpurea, marginem versus dilute flavida; coronæ verticillo exteriore in lacinias 70 radiantes diviso, his anguste linearibus, flavidis, e basi omnino liberis, quam corolla subbrevioribus, singulis vesicula parva effœta paullo supra basin extus munitis, verticillo intermedio depresse globoso, 40-nervio, nervis paullo supra basin vesiculis totidem parvis extus donatis, margine in lacinias 40 triplo breviores lineares obtusas inflexim conniventes scisso, verticillo interno e laciniis 20, a basi liberis, late linearibus, corollæ fere æquilongis, primum paullo erectis, versus medium inflexim descendentibus, apicibus obtusis sub stigma conniventibus, et hic anthera fertili oblonga fusca singulatim munitis. In Africa tropica: *v. s. in herb. Hook.* Old Calabar (*Mann*, 2272).

This plant, together with *N. Mannii*, has been referred to *N. Vogelii*, but differs from it in many salient characters. The axils of its thickish branchlets are ½ in. apart; the leaves are 6–8½ in. long (including the acumen 1 in. long), 2–2¾ in. broad, on a petiole 1–2 lines long. The calyx expanded is 10 lines across, its thick sepals being 3 lines long, 2½ lines broad at their base; the corolla is 1¾ in. in diameter; its nerves, not very prominent below, touch each other at their base, terminating acutely in the middle of the peripheral lobes. The 70 segments of the external whorl of the corona are 6 lines long, ¼ line broad, their prominent effete vesicles forming below a conspicuous moniliform ring 1 line beyond their base: the 40 segments of the second whorl, if free, would be as long as those of the external whorl; but they are confluent for two thirds of their length into a depressed globe, their free portions connivent at the centre, and the underpart of this globe not far from its base shows a prominent moniliform ring of 40 vesicles, similar to those of the outer whorl: the 20 free segments of the inner whorl are 7 lines long, 1 line broad, incurved as above mentioned, each furnished extrorsely near its apex with an adnate oblong fertile anther, these all crowding round the stigma. The style is extremely short and pentagonoid; the peltate pentagonal stigma, 5 lines broad, has 5 glandular spots near its angles, and scarcely rises above the level of the disk; the inferior ovary is compressedly turbinate, 5-celled, with several ovules in each cell, radiately attached to the projecting placentæ on the axis. The fruit is unknown.

6. Napoleona Mannii, nob.: ramulis subvalidis, pallidis, sulcato-striatis, epidermide resiliente: foliis majoribus, oblongis, imo obtusis vel rotundatis, apice in acumen subbreve obtusulum repente constrictis, marginibus undique integerrimis, subundulatis, rigide chartaceis, supra pallidis, valde opacis, sæpe cano-encaustis, nervis longe adscendentibus, subimmersis, subtus pallide fulvis, subnitentibus, minute

impresso-punctulatis, costa nervisque prominentibus, venis transversis et prominulis, imo sæpius eglandulosis; petiolo fusco, canaliculato, ruguloso, limbo 48plo breviore: flore solitario, breviter pedicellato, e gemma bracteolata axillari orto, pro genere parvo; sepalis acutis, sub apicem biglandulosis, extus pallide viridibus, pruinosis, intus flavidis; corolla undique flava, extus pruinosa, cum nervis obsolete costæformibus circa 30, in lobos totidem marginales rotundatos desinentibus, ambitu sepalos vix excedente; coronæ albæ verticillo exteriore e laciniis 40 anguste linearibus, e basi liberis, corollæ æquilongis, imo annulo moniliformi vesicularum signato; verticillo intermedio imo cupulari et hic annulo monilformi munito, pro tertia parte in lacinias 40 angustas incurvas centro conniventes diviso; verticillo interiore in lacinias 20 lineares complete introflexas secto, apicibus anthera oblonga fertili munitis, circa stylum conniventibus; stylo et stigmate ut in charactere generis. In insula Fernando Po: *v. pl. sic. in hb. Hook.* loc. cit. (*Mann*, 590).

A species differing from all others in its much larger and more rigid leaves with a very pale encaustic surface, in its solitary flowers, only half the size of any of the others, of a uniformly pale colour, furnished with a white corona peculiar in the number of its parts. It forms a tree 20–25 feet high, with branchlets $1\frac{1}{2}$ line thick, with axils 1 in. apart; its leaves are 10 in. long, 4 in. broad, on a petiole $2\frac{1}{2}$ lines long. The pedicel of its single flower is $\frac{1}{2}$ line long; the acute sepals are 4 lines long, 3 lines broad at their base; the corolla is 13 lines in diameter. The segments of the first whorl of the corona spread to a diameter of 13 lines; the diameter of the globular contour of the second whorl 8 lines. The fruit is unknown.

7. Napoleona angolensis, Welw. MSS.: ramulis teneris, pallidis, 4-angulatis, rugulosis: foliis elliptico-oblongis, imo subobtusis, apice in acumen subbreve vel longius obtusulum subito constrictis, marginibus distincte et undique crenato-serratis, membranaceo-chartaceis, supra viridibus, subopacis, nervis divergentibus semiimmersis, subtus pallidioribus, costa nervis venisque reticulatis prominulis; petiolo supra canaliculato, subtus valde corrugato, limbo 30plo breviore: floribus in axillis 3, e gemma ortis, quorum 2 alabastris, 1 expanso; pedicello vix ullo, imo decussatim bracteolato; sepalis 4 vel 5, acutis, apice 2-glandulosis, extus viridibus, intus flavescentibus; corolla late orbiculari, membranacea, subtus nervis 30 subulatis prominulis pallide pruinosis signata, ambitu in lobulos totidem rotundatos lacinulatos incisa, (sec. cl. Welw.) omnino nivea (sicca flavescente); coronæ verticillo exteriore e laciniis 60 liberis albis, anguste linearibus, acutis, imo tenuioribus, corolla dimidio brevioribus, singulis subtus vesicula minima munitis; verticillo intermedio pro dimidia parte cupuliformi, extus annulo moniliformi vesicularum instructo, margine in lacinias lineares 45 inciso, his introflexis, centro conniventibus; verticillo interiore e laciniis 20 late linearibus, liberis, introflexis, apicibus anthera fertili donatis, stylum circumstantibus: drupa sicca, depresse globosa, sinuato- 5-sulcata, pericarpio tenui, coriaceo, fragili, pallide rubidulo, punctis parvis flavidis immersis maculato, sicco uniloculari, intus septorum 5 vestigiis signato; seminibus reniformi-oblongis, subcompressis. In Angola: *v. pl. s. in hb. Welwitsch*; *v. fr. s. in Mus. Brit.* (*Welwitsch*).

A very distinct species, marked by peculiar characters. It forms a slender tree, 12 feet high, with a trunk 1–2½ in. thick, and with slender branchlets; its leaves, remarkable for their serrated margins, are generally 5 in. long, 2–2¼ in. broad, with about 7 pairs of nerves. Flower generally solitary, about the size of that of the typical species: the calyx expanded is 1 in. across from point to point; the sepals 4 lines long, 3 lines broad at their insertion round the disk, which is 3 lines in diameter; the corolla is 1¾ in. in width, or 9 lines long from the line of its attachment to the circumference: the segments of the outer whorl of the corona are 4½ lines long, ½ line broad; the total length of the half-confluent segments of the intermediate whorl is 8 lines, the free portion being one half of this, or 4 lines; the segments of the inner whorl are 6 lines long, 1 line broad: the fertile anthers 2 lines long. The fruit is 2¼ in. in diameter, 1½ in. high: the seeds are 1 in. long, 7 lines broad, 4½ lines thick; they are of a pale red colour, with close yellow immersed glands; the transverse short radicle is completely embedded within the substance of the cotyledons, close to the ventral sinus, which have no chink there, as in *N. Whitfieldii.* The tree was found in dense woods at Quitapo (Omnengue), between Ndelle and Rio Zuinha, in flower in May 1856, and in fruit at the end of June of the same year.

After this critical examination of the several species, we can perceive nothing, either in the floral or carpological structure of *Napoleona*, that bears the slightest analogy to the *Myrtaceæ*; it is equally irreconcilable with the *Barringtonieæ* and the *Lecythidaceæ*. In order to trace its real affinity, we will compare with it *Omphalocarpum*, a genus derived from the same vicinity.

2. Omphalocarpum.

This genus was first discovered by Palisot de Beauvais in 1787, in the same province where he found *Napoleona*; but it was not described and figured till 1804[1], when he pointed out its affinity with *Sapotaceæ.* All botanists since that time have accorded in this view[2]; but in 1862 Messrs. Bentham and Hooker, without adducing reasons, placed the genus in *Ternstrœmiaceæ*[3], and subsequently Prof. Oliver followed their example[4]; but notwithstanding such high authorities, I venture to think there is little in its structure conformable to that family, and an overwhelming amount of evidence to show that it is truly Sapotaceous. It forms lofty trees, with erect trunks; the leaves, not large, are approximated at the ends of the branches; the inflorescence generally issues out of the main trunk, or appears on the bare branches, rarely in the axils; the flowers, 3 to 6, usually spring from bracteolated tufts, and are mostly pedicellated, but in one species they are sessile; they are not very large, and are perhaps hermaphrodite in the typical species, but in the others they are more or less polygamous, as in other *Sapotaceæ*[5]. Of this we have parallel examples in that family where there is an

[1] Fl. Owar. i. p. 6, tab. 5 et 6.

[2] Lam. Dict. Suppl. iv. 140, tab. 966; Brown, Prodr. p. 529; DC. Prodr. viii. 207; Endl. Gen. p. 741; Lindl. Veg. Kingd. p. 591; Hook. Niger Flora, p. 441.

[3] Gen. Plant. i. 185.

[4] Flor. Afr. 171.

[5] Miq. Monogr. Sapot. in Mart. Fl. Bras. fasc. xxxii. p. 38, where he says "flores *fere* semper hermaphroditi."

exuberant production of flowers, as in *Mimusops*. The sepals are 5, roundish, subcoriaceous, very imbricated, the 2 exterior nearly concealing the others in æstivation, as in *Sapotaceæ*. The corolla is described by DeCandolle[1] as gamopetalous and infundibuliform, deeply cleft into 6 or 7 distinct segments: this, however, is not a correct definition; for in reality there are 5 petals (in one species more), all furnished with cuneiform claws, which are firmly agglutinated upon the outer surface of a funnel-shaped thin disk, leaving the upper and broader portions apparently as so many free segments, which are erect, oblong, and somewhat imbricated on the margin: the proof of this is clearly shown on examining the outside of the tube, where we see the margins of the claws free, like so many very narrow wings, extending to the base, leaving narrow portions of the bare disk visible between them. The disk, as above shown, is tubular, as long as the claws of the petals, and agglutinated to them, just as occurs in *Mimusops* and *Lucuma*; and in like manner it supports upon its margin 5 sets of stamens, nearly the length of the free portion of the petals, and placed opposite to them in a single series; their filaments are straight and slender, very pointed and recurved at the summit, where they support each a versatile anther, composed of 2 long collateral cells, divergent at the base, and fixed extrorsely upon a fleshy connective, which is uncinately excurrent at the apex; if we cut this anther in its young state transversely, it appears 4-celled; but as the dehiscence takes place in the deep furrows, it is seen to be only 2-celled, each cell containing 2 parallel masses of cohering pollen grains; after bursting they become separated, then appearing oval and reticulated: the same number of filaments, similar in every respect, are seen in the ♂ and ♀ polygamous flowers, but they are antheriferous in the former and bare in the latter. Between these sets of fertile stamens, and alternate with the petals, are seen as many processes, strap-shaped below, widening upwards, where they are flabellately laciniated into about 7 setaceous segments, the middle one longest, attaining the length of the fertile stamens; these exactly resemble the so-called staminodes found in *Mimusops*, *Lucuma*, and *Dipholis*. The ovary is superior; in the ♂ flower it is rather small, orbicular, fixed on a short stipitate support, depressed above, where it is marked by many radiating grooves, bearing in the centre an erect slender style, reaching the anthers, and terminated by a small many-lobed hollow stigma; it contains an irregular number of cells, each with a small ovule, probably all abortive; in the ♀ flower the ovary is larger, and fixed on a stipitate support, is many-grooved, and expands above gradually into a stout conical coriaceous style (as long as that of the ♂ flower), obtuse at the summit, where it is hollow and many-lobed: when this style is cut transversely, we see there as many distinct channels as there are cells in the ovary, and descending into them; there are about 24 cells, radiating from a hollow central axis, with a single ovule in each cell, horizontally attached: all this agrees with the structure of *Mimusops*. The fruit is large ($4\frac{1}{4}$–$8\frac{1}{2}$ in. in diam., sometimes much larger), of a very depressed orbicular form, radiately sulcated, umbilicated in the centre by a large hollow space, in the bottom of which the persistent style is seen: the indehiscent pericarp is $\frac{1}{2}$–1 inch in thickness; the epicarp is hard and subligneous: the mesocarp, composed of many distinct, ovoid, subcompressed, grumous concretions (as in *Labatia*), like the nodules of a mineral con-

[1] Prodr. viii. 287.

glomerate, irregularly interwoven in two series; these nodules are easily separable in the fresh state, but afterwards become solidified and compact: the central space is divided into about 20 narrow cells by dissepiments, which radiate around a large hollow orbiform ligneous axis, which is internally smooth and polished: the placental angle of each cell thus inclines upwards and outwards, and bears a single seed attached to it by a long linear caruncle or scar. This seed is oblong, very compressed, much thinner towards the margins, rounded on three sides, but straight along the whole ventral edge, and there marked by a pale opaque soft caruncula, as in *Sapota*, where it is called by DeCandolle the umbilicus, but by Gaertner the umbilical area, to distinguish it from the true umbilicus always seen on one of its extremities, as figured in his plate 203, and so described in his text under *Lucuma*, *Sapota*, *Chrysophyllum*, *Sideroxylon*, *Mimusops*, and *Imbricaria*; in the present instance the hilum is seen at its lower extremity, like an oval hole divided by a septum, the remaining part being filled with the ascending raphe, terminating at the opposite extremity in a small foramen, which it perforates to terminate in the apical chalaza. The testa is polished externally, is rather thick, very hard, osseous, dark brown, expanded at each ventral angle into a short hooked rostrum, the lower one marked by a transverse chink (the micropyle); the inner integument is brown, chartaceous, and adheres firmly to the inside of the testa. In the only seed I was able to examine, the thinnish albumen alone was present, the enclosed embryo being abortive or decayed; but this is well figured by Palisot, who figures it as consisting of 2 large thin foliaceous cotyledons, united at their base by a small inferior radicle.

The genus is thus seen to agree remarkably with *Sapota* in the structure of its flower, of its fruit, and especially in that of its seeds; indeed it differs from the latter only in its large umbilicated fruit with a hard ligneous pericarp, having a large hollow axis. I will here record the two following species.

1. Omphalocarpum procerum, Pal. Beauv. Fl. Owar. i. p. 6, tab. 5 et 6; R. Brown, Prodr. p. 529; Poir. Dict. Suppl. iv. p. 140, tab. 966; DeCand. Prodr. viii. 208: arbor comosa, trunco altissimo, ramis patentibus, ramulis diffusis: foliis alternis, sessilibus, lanceolatis, integris, glabris, supra nitidis: floribus solitariis vel pluribus fasciculatis, sessilibus, e trunco nascentibus, hermaphroditis?; sepalis 10 (quorum 4–5 forsan bracteis?), valde imbricatis, ovato-rotundis, concavis, extus sericeo-villosis; petalis 6–7, oblongis, margine undulatis, glabris, imo longe unguiculatis, unguibus ad discum tubulosum perigynum petalis triplo breviorem agglutinatis, corolla hinc pseudo-monopetala; staminibus in phalangibus 6–7 petalis oppositis margini disci insertis, filamentis tenuibus, antheris oblongis, cum connectivo subulato exserto; staminodiis 6–7, singulatim inter quidque petalum disco insertis, petalis 3plo brevioribus, oblongis, membranaceis, margine fimbriatis; ovario supero, depresse globoso, multiloculari; stylo subulato-tereti, petalis breviore, persistente; stigmate capitato, aspero: fructu permagno, indehiscente, orbiculari, valde depresso, plurisulcato, apice profunde umbilicato, extus turgide tuberculato; pericarpio duro, crasso, e concretionibus majusculis confecto, radiatim pluriloculari; semini-

bus in loculis solitariis (pulpa involutis?), oblongis compressis, margine ventrali caruncula lineari signatis, angulis ventralibus singulis rostratis; embryone oblongo, in albumen tenue subæquilongum immerso, cotyledonibus 2 magnis foliaceis ellipticis, radicula parva infera. In Africa occidentali (Upper Guinea) ad Buonopozo, regione Galbar ultra regnum Owariense, a cl. auct. lectum (non vidi).

According to Palisot, this is a tree with a lofty straight trunk, 60–80 feet high, of which he gives a diminished drawing: the size and exact contour of the leaves are not given, only that they are lanceolate, and therefore different from the specimens in the Kew herbarium from the Camaroons and Old Calabar. The flowers also differ from those of the latter in being hermaphrodite, sessile, and pentamerous; the sepals sericeously villous; they are 1 inch long. The fruit is large, often 12 inches in diam.; the seeds are 1 in. long, ½ in. broad. From Palisot's ample generic character, there is nothing that can lead us to suppose that the flowers are otherwise than hermaphrodite.

2. Omphalocarpum elatum, nob,: *Omphalocarpum procerum*, Oliv. (non Palisot), Afr. Flor. i. p. 171: ramulis apice foliiferis, deorsum nudis, axillis approximatis: foliis oblongis, imo longe spathulatis, apice rotundiusculis, vel sensim obtusatis, majusculis, integris, marginibus subrevolutis, rigide chartaceis, glaberrimis, supra rufescenti-viridibus, subpruinoso-opacis, costa planata, griseo-pruinosa, striolata, nervis divergentibus arcuatim nexis, prominulis, subtus ferrugineo-opacis, costa prominente, nervis flexuosis prominulis, venis transversim reticulatis; petiolo brevissimo, late concavo, fusco: floribus 5–6, e nodo bracteolato trunco innascenti-fasciculatis, pedicellatis; sepalis semper 5, ovatis, concavis, pedicello æquilongis, valde imbricatis, quorum 3 exterioribus subglabris, crassioribus, 2 intimis submembranaceis, cano-tomentellis; corolla flava structura præcedentis, sed petalis phalangis et staminodiis semper 5: staminibus in quaque phalange uniseriatim 6, petalis oppositis, et iis dimidio brevioribus, erectis, apice subito reflexis; antheris supra medium affixis, extrorsum collateraliter 2-lobis, acute oblongis, connectivo excurrente; ovario depresse globoso; stylo subulato; stigmate capitato; in ♀ ovario imo breviter stipitato, cylindrico, pluriloculari, stylo cum eo continuo obconice cylindrico, stigmate annulari vacuo pluridenticulato dentibus cum styli canalibus ovariique loculis congruentibus: fructu forma præcedentis, sed dimidio vel duobus trientibus minore, extus sublævi (vix tuberculato), 24-loculari; seminibus similibus. In Africa occidentali: *v. pl. s. in hb. Hook.* ♂ Bagroo river (*Mann*, 815), Old Calabar (*Thomson*, 128); ♀ Camaroon river (*Mann*, 712): *v. fr. s. in Mus. Kew.* Camaroon river (*Mann*).

A species very distinct from the preceding; its height is unknown. In Mann's specimen from Bogroo river the leaves are broader, 5–9 in. long, 2¼–3¼ in. broad, on a petiole 2 lines long; those of Mann's two specimens from the Cameroons are 5–9 in. long, 1¼–2½ in. broad. Thomson's specimen consists of a single leaf, 9½ in. long, 2¼ in. broad, cuneate at base, where it is ½ in. broad, without a petiole: it belongs probably to

a different species. The flowers are nearly 1 inch long; the sepals are 4 lines long, 3 lines broad; the funnel-shaped disk 4 lines long, the claws of the petals glued to it are of the same length, their free portions above being 7 lines long, 3 lines broad; the filaments in both sexes are slender, erect, 5 lines long; the anthers 2 lines long, acute above, cordate at the base, being fixed behind at the sinus to the recurved apex of the filament, standing extrorsely. The fruit in one case is $4\frac{1}{4}$ in., in the other $5\frac{1}{2}$ in. in diameter, and 3 in. high, the pericarp being 10 lines in thickness, and composed of conglomerate nodules, as is well described by Beauvais; the seeds are $1\frac{1}{2}$ in. long, 1 in. broad, and 4 lines thick in the middle.

It is thus seen that the structure of its flower resembles that of *Mimusops*, differing only in its isomerous petals, in the greater number of its fertile stamens, and in their greater length; it comes close to *Sapota*, especially in its fruit and seeds; and here it will find its proper place.

If we now carry out our proposed comparison between the structures of *Napoleona* and *Omphalocarpum*, we discern many points of singular analogy. They both come from the same region. They have an inflorescence in which the fasciculated flowers grow out of bracteolated nodules, a calyx of 5 sepals, a corolla perfectly monopetalous in one case, pseudo-tubular in the other, both furnished inside with separate phalanges of fertile stamens having extrorse anthers; phalanges of sterile stamens alternately placed in one case, concentrically disposed in the other; a plurilocular ovary, with one or two ovules in each cell; an indehiscent plurilocular fruit, orbicular, depressed, and umbilicated in the apex; and what is more remarkable, they both possess the very unusual character of a hollow axis, causing the placentæ to become inclined, with a solitary seed in each cell, attached to it by a ventral scar common to all *Sapotaceæ* (the "umbilical area" of Gaertner), a soft place which is probably only an expansion of the raphe. But, on the other hand, the differences are so great between the two genera as absolutely to prevent the admission of *Napoleona* into the *Sapotaceæ*; it differs in its sepals with valvate æstivation, a completely monopetalous corolla, in having its staminodes arranged in concentric whorls (although *Dipholis* has phalanges of 3 staminodes arranged concentrically in a double series); it has an epigynous (not a perigynous) disk, an inferior (not a superior) ovary and fruit, exalbuminous seeds (though these occur in *Lucuma* and *Labatia*). If, then, *Napoleona* cannot be admitted into the *Sapotaceæ*, and there is no other natural order in which it can possibly find a place, it must remain the monotypic representative of a distinct family, the *Belvidiaceæ*, as originally maintained by Brown and Lindley, excluding, however, *Asteranthos*. This family, though now consisting only of a single genus, must be placed in juxtaposition with the *Sapotaceæ*; and it is highly probable that other forms closely allied to it may be found in the forests, so full of rich vegetation, in the yet unexplored regions of tropical Africa.

3. Asteranthos.

Although this genus has been associated hitherto with *Napoleona*, it will be shown that it does not bear the smallest affinity with it. It is entirely of South-American

origin, and, excepting the contour of its corolla, it presents quite another aspect, and a floral structure different in every respect. Only one species is recorded.

1. ASTERANTHOS BRASILIENSIS, Desf. Mém. Mus. vi. p. 9, tab. 3; D'C. Prodr. vii. 551. In Brasilia et Venezuela: *v. s. in hb. meo et alior.* Rio Guainia (*Spuce*, 3500).

The plant above quoted is one of the gems of Dr. Spruce's invaluable collection; it was found by him on the banks of the river Guainia, the main branch of the Rio Negro, about 60 miles within the confines of Venezuela, and therefore not in Brazilian territory. It is probably a species distinct from Desfontaine's; for the latter has smaller leaves, larger flowers, a broader and deeper calyx, more resembling "the cup of an acorn," has much longer stamens, an ovary said to be inferior, with a 6-rayed vertex, and a stouter style and stigma. Spruce's plant is apparently a shrub, with upright alternate branches, the axils being $\frac{3}{4}$ in. apart; alternate leaves, oblong, subacute at base, with a long, narrow, obtuse acumen, their undulated margins subrevolute, especially towards the petiole; they are dull above, with nerves wholly immersed, pruinosely opaque and paler beneath, veinless, with a slightly raised midrib; $2\frac{3}{4}$–$3\frac{1}{4}$ in. long, 1–$1\frac{1}{4}$ in. broad, on petioles 1 line long. The inflorescence consists of a solitary flower in each axil, articulated on a short gemmiform nodule, bearing a minute bract; the pedicel is slender, erect, 9 lines long; the calyx is orbicular, very depressed, $1\frac{1}{2}$ line broad, 5 lines in diameter, its concave margin cut into about 16 blunt short teeth, each terminating in a curving bristle. The corolla is a circular, depressed, membranaceous cup, plicated in æstivation, as in *Cordia*; expanded, it is $2\frac{1}{4}$ in. in diameter, with an upturned margin, divided into 24 short roundish teeth, sparsely and setosely ciliated on their margins, and they correspond with as many fine nerves radiating from the centre, the intervening spaces being reticulated with fine veins; it is of a dull yellow colour when dry; it is attached by its perforated centre to the margin of a narrow, circular, annular, epigynous disk, 3 lines in diameter. The disk supports very numerous stamens, all quite free from the corolla, in three or four series of different lengths; the very close slender filaments are straight, the outer series 3 lines, the inner row 2 lines long, each bearing a linear-oblong, 2-celled anther, bursting by lateral sutures, introrsely and dorsally fixed on the curving apex of the filament, a little above the base; the ovary is quite superior, rising within the disk in a conical deeply 8-ribbed vertex, surmounted by a subulate slender style, 3 lines long, terminating in a capitate hollow stigma, with an 8-toothed margin; the ovary has eight cells opposite the ribs, each with a prominent placenta emanating from the axis, and charged with several collateral ovules, arranged in about three superposed series, with the raphes of the anatropous ovules facing each other. The fruit is unknown.

This structure is so widely different from that of *Napoleona* that *Asteranthos* cannot possibly remain in contiguity with it; the calyx is quite dissimilar in form, and has another æstivation; its flower presents no trace of the corona which forms such a peculiar feature in *Napoleona*; there is no analogy in the form, structure, or position of the stamens; the ovary is superior, with a long slender style, and an extremely dissimilar stigma; in fine, there is no single point of resemblance of its parts except in the orbicular shape of its corolla, an adventitious feature of weak value (insufficient to establish any

claim to affinity), and even there it is constituted very differently; for in *Asteranthos* its texture is that of an ordinary monopetalous corolla, simply marked by several delicate nerves, with intervening reticulated veins, as, for instance, in the campanular corolla of some species of *Cordia*, which have a very similar æstivation.

Searching among the many genera with a monopetalous corolla, we come upon *Rhododendron*, where we find many unexpected points of resemblance. *Asteranthos* has precisely the calyx figured by Wight (in his Icones, pl. 1203) of *Rhododendron Griffithsianum*; that species has a broad campanular corolla, with many longitudinal nervures, and is divided on its margin into several teeth; the tube is plicated with a similar æstivation; though its stamens are more numerous, they have similar long slender filaments, seated on a thin disk, free from the corolla, and similarly formed anthers; it has a superior conical ovary, of the same shape, marked in like manner by salient ridges, corresponding with the number of the cells, a similar long slender style, and a remarkably similar stigma. There would be no difference in the anthers if, in *Rhododendron*, the apical pores were continued in a slit along the remainder of the sutures, as, indeed, actually occurs in *Azalea*, where their dehiscence is like that in *Asteranthos*; other points of analogy are found in the arborescent species of *Rhododendron*, where the leaves are as frequently alternate as they are opposite, and where the large flowers are, in like manner, seated upon long, slender, solitary pedicels, bracteolated at their base. There is nothing, therefore, to separate this genus from others of the *Rhododendreæ*, except a more rotate corolla, with more numerous and shorter lobes. When the fruit is known, other analogies may be found to exist; but under our present knowledge of the structure of *Asteranthos*, it may safely be regarded as a member of the tribe just mentioned. It may be added that *Rhododendron maximum*, with a large, almost rotate corolla, is a native of South Carolina, a circumstance which renders the relationship more complete.

DESCRIPTION OF THE PLATES.

Plate I.

Fig. 1. A leaf of *Napoleona imperialis*, from a specimen sent by Palisot de Beauvois to Rob. Brown.

2. A leaf of *Napoleona Whitfieldii*, from Whitfield's specimen.
3. A fruit of the same species, from Whitfield's collection.
4. The same in longitudinal section, to show its thin pericarp.
5. A seed from the same, seen on its face.
6. The same, shown on its edge.
7. One of its cotyledons seen on its inside face, showing the radicle and plumule half immersed in it.
8. A leaf of *Napoleona angolensis*, from Welwitch's specimens.
9. A fruit of the same species.
10. A longitudinal section of the same, showing its thin pericarp.
11. A seed belonging to the same, shown on its face.
12. The same, seen edgeways.

Plate II.

Fig. 1. A leaf of *Napoleona Mannii.*
2. A flower of the same, viewed from above.
3. The same, as seen from beneath.
4. A leaf of *Napoleona cuspidata.*
5. A flower of the same, viewed from above.
6. The same, as seen from beneath: *all nat. size.*

Plate III.

Section A. Analysis of *Napoleona Vogelii.*

Fig. 1. A flower, seen from above.
2. The same, viewed sideways.
3. The corolla detached from its insertion on the disk, and seen from below.
4. The outer whorl of the corona detached, consisting of 75 free, radiating, narrow segments: *all nat. size.*
5. Three of the same segments, shown in different positions: *magnified,* to show the vesicles or abortive anther-cells.
6. The second whorl of the corona, showing 40 segments, confluent on their margin for half their length into a hemispherical cup, while the free portions are inflected and connivent over the stigma.
7. A side view of the same.
8. The same, forcibly expanded, to show the comparative length of the segments.
9. The inner whorl of the corona, consisting of 10 free stamens, inflected so that the terminal extrorse anthers are brought beneath the stigma.
10. The same, with their filaments extended to show their relative length: *all nat. size.*
11. Three of the stamens, in different positions: *magnified.*
12. The calyx, seen from below.
13. The same, viewed from above.
14. The stigma: *all nat. size.*
15. The same: *magnified.*
16. A longitudinal section of the 5-celled inferior ovary, of the short style and broad stigma, of the abbreviated vertical disk, from which the corolla and the 3 whorls of the corona have been removed, showing also the hollow central axis and 2 erect ovules fixed near the base in each cell: *magnified.*
17. A diagram of the parts of the flower in longitudinal section: *nat. size..*
18. A fruit of the same species, crowned by the calyx, with a quarter of it cut away, showing in longitudinal section the much thicker pericarp, the hollow axis, and 2 seeds in the natural position.
19. A transverse section of the same, showing 9 radiating cells, with a single seed in each cell, without any enveloping pulp, as seen in a specimen preserved in spirits in the Kew Museum.
20. A seed, shown on its face, with a caruncular ventral scar.
21. The same, seen on its edge.
22. The same, on its face, with the thin integument removed.
23. One of the cotyledons, viewed from its inside face, showing the radicle and plumule half-immersed within the sinus.

Fig. 24. The radicle and plumule removed: *all nat. size.*

25. A seed of *Napoleona Heudelotii,* showing its different form.

26. One of its cotyledons, with the immersed radicle: *nat. size.* Both copied from Jussieu's drawing.

Section B. Analysis of *Asteranthos brasiliensis.*

Fig. 1. A portion of a branchlet, showing a leaf with its axillary flower.

2. A flower in bud, showing the mode of æstivation of its plicated corolla.

3. The same, when full-grown and naturally expanded, showing the three series of many free stamens seated round the disk on the base of the corolla, as seen from above: *all nat. size.*

4. Five of the stamens removed: *all nat. size.*

5. The same: *magnified.*

6. The calyx, disk, superior 8-celled ovary, style, and stigma: *nat. size.*

7. The same, seen in a longitudinal section, to show the ovules suspended from the placenta in the axis of each cell: *magnified.*

8. The same, as seen from above, showing the disk round the deeply 8-grooved conical ovary: *both magnified.*

9. The cup-shaped, 8-toothed, hollow stigma, seen also in longitudinal section: *more highly magnified.*

10. An ovule: *much magnified.*

Plate IV.

Analysis of *Omphalocarpum elatum.*

Fig. 1. A portion of the plant.

2. A fascicle of flowers, taken from the trunk of the tree.

3. The calyx.

4. The pseudo-tubular male corolla, showing the 5 petals agglutinated by their long claws to a membranaceous tubular disk.

5. The same cut open, showing 5 phalanges, each consisting of 6 equal stamens, seated on the margin of the agglutinated disk opposite each petal, with an intermediate fringed staminode alternating between each series.

6. A portion of the disk supporting its 6 fertile stamens and 2 of the staminodes: *all nat. size.*

7. Three of the same stamens: *magnified.*

8. Transverse section of an anther before and after dehiscence: *more magnified.*

9. The abortive ovary and style: *nat. size.*

10. The same: *magnified.*

11. The corolla of the female flower, similar to that of the male in every respect except that the stamens are all anantherous.

12. A portion of the agglutinated disk supporting a set of sterile filaments and two of the alternating fimbriated scales.

13. A fertile superior ovary, continuous with a long conical thick style.

14. A longitudinal section of the same, showing the hollow style bearing the channels leading to the many cells of the ovary, and surmounted by the open many-toothed stigma: *all nat. size.*

15. Shows a *magnified* view of fig. 13.

16. A transverse section of the ovary, showing its 25 cells radiating round its hollow axis: *also magnified.*

Fig. 17. A fruit, the smaller specimen in the Kew Museum, viewed sideways, with a quarter segment cut away, to show the conglomerate-like structure of the thick pericarp, the persistent style, the singular hollow axis, and the solitary seed in each cell, attached to the axis.

18. A moiety of the same fruit, seen in transverse section, showing the many radiating cells placed round the large hollow axis, each with a single seed attached in the axes.

19. One of the seeds (like that of *Lucuma*) shown on its face.

20. The same, shown on its ventral edge, which is grooved where the ascending raphe is imbedded, and in the bottom of which a very small hilum is seen.

21. A longitudinal section of the same, parallel with its faces, showing the enclosed nucleus.

22. The nucleus extracted, seen on its edge.

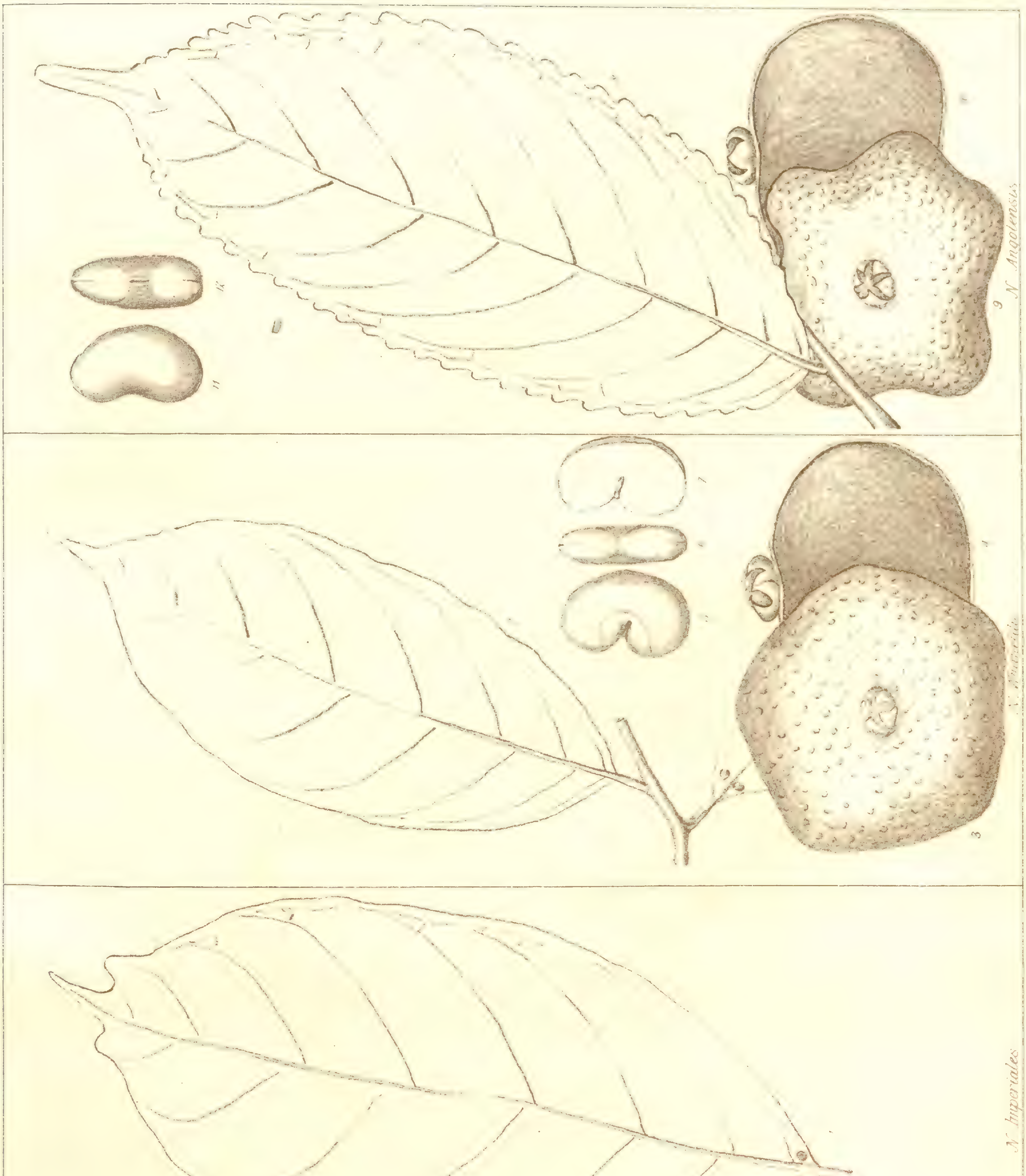
23. A longitudinal section of the same parallel to the faces, showing the embryo enclosed in thin corneous albumen.

24. The embryo extracted, seen on its face.

25. The same, shown on its edge.

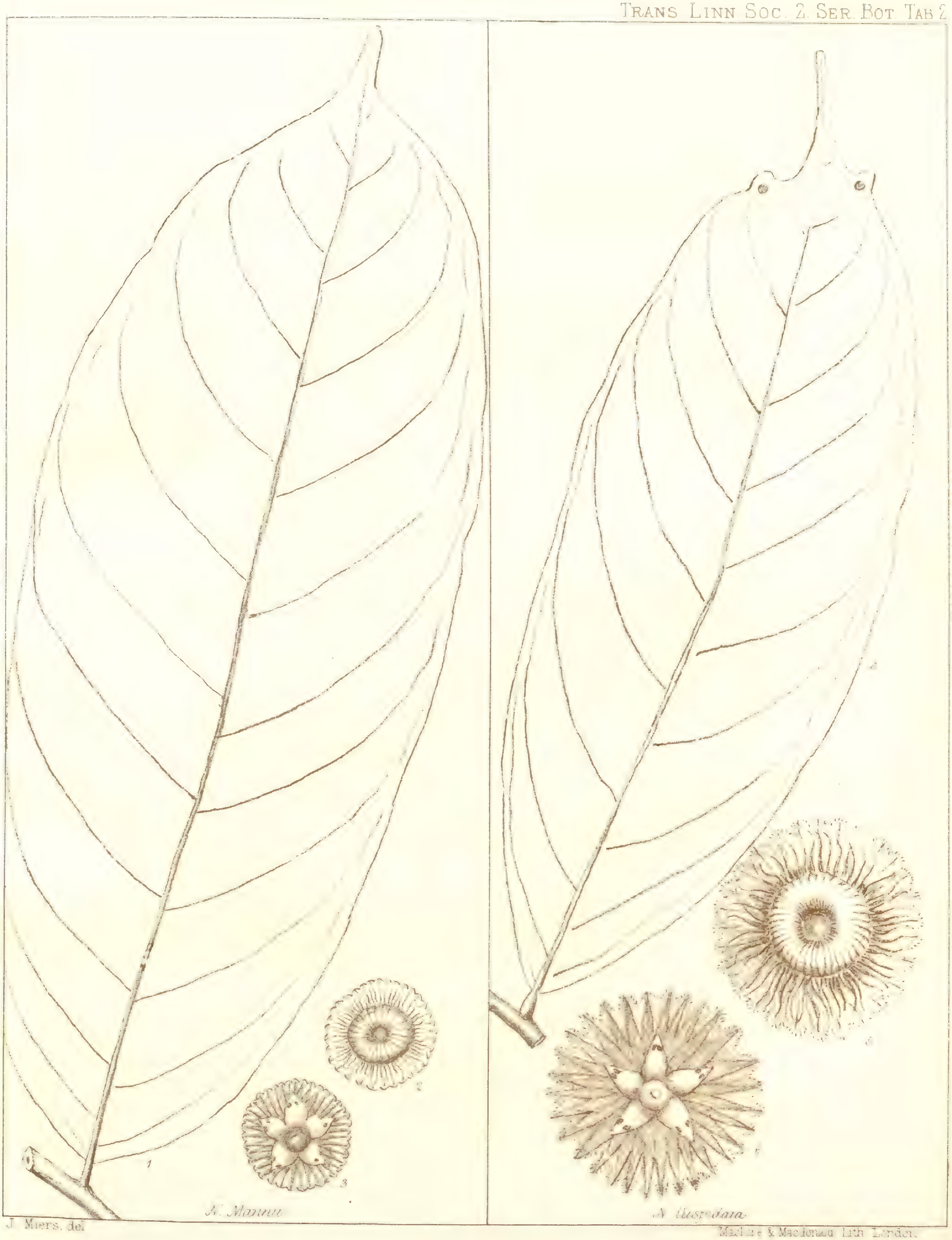
26. A seed from the larger specimen of the fruit in the Kew Museum, shown on its face.

27. The same shown on its ventral edge, which is channelled by the raphigerous groove, in the bottom of which is seen the hilum, *h*, and near its summit the perforation, *f*, through which the chord of the raphe passes into the interior. Near the basal point the micropyle, *m*, is distinctly seen; this structure is precisely that of *Lucuma* and *Imbricaria*, shown by Gaertner.



J. Miers del. Lith. London

NAPOLEONA



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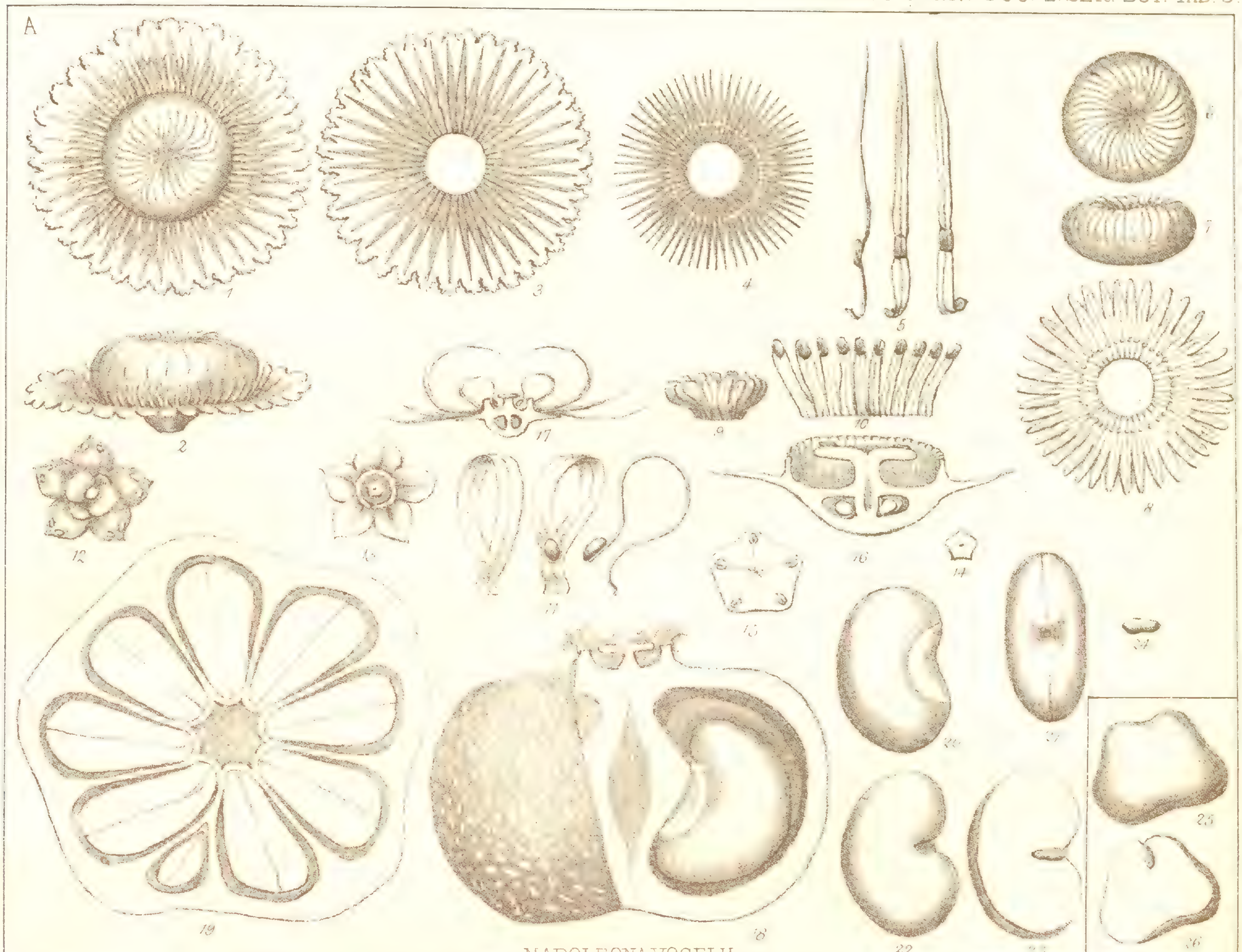
NAPOLEONA.



NAPOLEONA VOGELII.

J. Miers del.

Maclure & Macdonald, Lith. London

ASTERANTHOS BRASILIENSIS.

J. Miers, del.

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OMPHALOCARPUM ELATUM.

II. *On the* Auxemmeæ, *a new Tribe of the* Cordiaceæ.

By John Miers, *F.R.S.*, *V.P.L.S.*, *&c.*

(Plates V.–VIII.)

Read June 18th, 1874.

THIS memoir, written five years ago, and alluded to on a former occasion *, describes a small group of plants marked by very peculiar characters. They are distinguished chiefly by the unusual growth of the calyx, which often increases in an extraordinary degree as the fruit advances to maturity; but they are more especially remarkable for the atropous development of their ovules and seeds. The group, consisting of the genera *Auxemma*, *Sacellium*, *Hymenesthes*, *Patagonula*, *Paradigma*, and *Plethostaphia*, may thus be characterized :—

AUXEMMEÆ.

Tribus Cordiacearum. *Flores* hermaphroditi. *Calyx* tubulosus, dentatus aut divisus, demum amplificatus. *Corolla* tubulosa. *Stamina* inclusa. *Ovarium* superum, *disco* carnoso hypogyno insitum, 4-loculare : *ovula* in quoque loculo solitaria, erecta, et atropa. *Drupa* carnosa, vel subexsucca, monopyrena : *pyren* ossea, rugosa, 4-locularis, aut abortu 2-locularis : *semen* in loculo solitarium, structura *Cordiæ*, sed omnino atropum.

1. Auxemma.

The type of this genus is a curious Brazilian plant found by Gardner, who regarded it as a species of *Patagonula*, and mentioned it in his 'Travels,' p. 159. The flower, in structure, is not unlike that of the genus just mentioned, has a more tubular calyx, which becomes vastly inflated around the fruit, increasing to about 30 times its original length, and swelling proportionally. The drupe, which it conceals, is nearly of its length, and about the size and shape of a small damson, containing a hard scrobiculated nut, which is 4-celled; its seeds distinctly atropous. The generic name is derived from αὔξω, *amplifico*, ἕμμα, *vestis*, from the singular enlargement of the calyx.

Auxemma, nob.

Calyx parvus, tubulosus, membranaceus, ore 5-dentatus, persistens et in fructu valde amplificatus. *Corolla* tubulosa; *tubus* cylindricus, calyce dimidio longior, subplicatus, fauce vix ampliore; *limbi lobi* 5 æquales, rotundato-ovati, tubum subæquantes, subexpansi, æstivatione introflexi, cum apicibus incurvatis centro conniventes. *Stamina* 5, lobis alterna, inclusa, inæqualia, tubo dimidio breviora; *filamenta* tenuia, paulo supra basin tubi inserta: *antheræ* ovatæ, 2-lobæ, lobis filamento adnatis, rima laterali utrinque dehiscentibus. *Discus* hypogynus, carnosus. *Ovarium* superum, disco insidens, conico-ovatum, 4-loculare; *ovula* in loculis solitaria, e basi erecta, atropa: *stylus* brevis, ultra medium 2-fidus, ramis divaricatis bifidis: *stigmata* 4, oblique clavata, corolla inclusa. *Calyx* in

* Contrib. Bot. ii. 261.

fructu magnopere auctus, inflatus, reticulato-membranaceus, vesiciformis, plicato-pentagonus, imo ad angulos in saccis prolatus et hinc profunde cordatus, fauce dentibus 5 angulis continuis sensim valde constrictus: *drupa* ter brevior inclusa, ovata, nitida, sarcocarpio amplo spongiose carnoso vestita, apice subumbilicata et stylo rostrata, monopyrena: *pyren* osseus, ovoideus, apiculatus, extus echinato-rugosus, apice 4-locularis, imo in cruribus 4 loculis oppositis prolatus, interstitiis cum centro excavato materia medullari farctus: *semina* in quoque loculo solitaria, atropa, erecta; *testa* tenui, *hilo* basilari cum *chalaza* confuso versus angulum notata; *embryo* exalbuminosus; *radicula* supera, brevis, teres; *cotyledones* 2, amplæ, crasso-foliaceæ, multiseriatim longitudinaliter plicatæ.

Arbuscula *Brasiliensis, frondosa, ramosissima*; folia *alterna, oblonga, petiolata*; paniculæ *in ramulis terminales, dichotome ramosissimæ, multidivisæ*; flores *parvi, plerique mox decidui.*

1. Auxemma Gardneriana, nob.: ramulis subangulatis, striatis, pallide brunneis, glabris, axillis subapproximatis: foliis lanceolato-ellipticis, imo sensim cuneatis, apice obtusis, grosse et remote dentato-sinuatis, utrinque glabris, supra subnitidis, subtus pallidioribus, nervis prominulis; petiolo tenui, limbo 9plo breviore: panicula in ramis alaribus laxa, 5–6ies dichotome divisa, artubus ultimis tenuissimis scorpioideis; floribus parvis uniserialiter sessilibus, unico maturescente, reliquis deciduis; calyce breviter 5-dentato, dense rigide pubescente; corollæ tubo membranaceo, 5-plicato, glabro, fauce ampliore, limbi lobis rotundato-oblongis, expansis, tubum æquantibus, utrinque (sed extus densius) rigide pubescentibus; staminibus 5, æqualibus, inclusis, imo tubi enatis, glabris; ovario oblongo, subconico, parvo, dense piloso; stylo piloso: drupa ovata, subcarnosa, nigra, nitida, calyce valde ampliato abscondita, monopyrena: cæt. ut in char. gen.—In Brasilia, prov. Ceará: *v. s. in hb. Mus. Brit.* inter Aracati et Ico (*Gardner*, 1779).

This is described by Gardner in his travels (*loc. cit.*) as a tree growing gregariously and abundantly in the province of Ceará, where it is known by the name of *Páo branco* (white wood); it grows to heights of from 20 to 40 feet, its wood, not very hard, being extensively used by the natives for fuel. The branchlets are 2 lines thick, with axils $\frac{1}{2}$–$1\frac{1}{2}$ in. apart; the leaves are 5–$6\frac{3}{4}$ in. long, 2–$2\frac{1}{4}$ in. broad, on petioles $\frac{1}{2}$–$\frac{3}{4}$ in. long; the axillary panicle is about 3 in. long and broad, 5 or 6 times dichotomously divided; the ultimate divisions are very slender, $\frac{1}{2}$ in. long, bearing on one side about 8 or 10 nodules where the sessile flowers were attached; but in the dried specimen only a single flower remains upon the spikelets; the calyx is 2 lines long, $1\frac{1}{2}$ line broad; the tube of the corolla 2 lines long, the lobes of the border 2 lines long, 1 line broad; the filaments $\frac{3}{4}$ line, the ovary $\frac{3}{4}$ line long, the style of the same length. In fruit the enlarged calyx is $2\frac{1}{4}$ in. long, $1\frac{3}{4}$ in. broad, membranaceous and reticulated, with 5 acute angles, terminating below in 5 large hollow sacs which extend half an inch below the summit of the thickened spikelet, tapering upwards to a width of 4 lines, and terminated by 5 erect teeth; the drupe, fixed on the point of attachment, is $\frac{3}{4}$ in. long, 8 lines broad; the sarcocarp thick, soft, and spongious, enclosing an osseous nut with an uneven surface, with a hollow space below, filled with medullary matter; above, it has four cells, two of which are smaller, but all four contain each a single erect seed; in the base of each cell a foramen is seen for the passage of the nourishing vessels to the basal chalaza of the seed, which is nearly 3 lines long; its two integuments are white, very thin, and brittle, marked at the pointed summit by the micropyle; there is no trace of a raphe or other spiral vessels.

2. Sacellium.

This genus was established in 1808, by Bonpland, in the 'Plantæ Æquinoctiales,' where there is an imperfect description and a drawing of the typical plant. From the few particulars known of it, there can be no doubt that the genus closely approximates to *Auxemma*, agreeing with it in its enlarged inflated calyx enclosing a small monopyrenous drupe, with a 4-celled nut of similar structure. On account of the extreme difference in the appearance of the flower in its early and later stages, Bonpland erroneously concluded that the inflorescence was monœcious, bearing male and female flowers in the same panicle; but his evidence does not support this conclusion. Bonpland, who has no high claim as an observing botanist, confesses that such details of the floral structure he owes to Humboldt, who made the drawing above referred to. Kunth, 17 years later, examined Humboldt's specimen, which had no flowers, and he had only the original sketch of the latter to guide him. In regard to the fruit, he ascertained that its nut had 4 seminiferous cells in its summit; and he noted the existence of the inferior cavities figured by Humboldt, in which he found no trace of seeds. Judging by analogy, we have here, therefore, precisely the same structure as that I have described in *Auxemma*. Upon these materials a reformed generic character is constructed in the following manner:—

Sacellium, Humb. & Bonpl.

Flores hermaphroditi. *Calyx* primum parvus, tubulosus, 5-dentatus, persistens et in fructu magnopere augescens. *Corolla* brevissime tubulosa, fere ad basin 5-fida, laciniis oblongis. *Stamina* 5, imo tubi affixa, brevia, subinclusa. *Ovarium* superum, *disco* hypogyno crassiusculo insitum, 4-loculare, loculis 1-ovulatis; *stylus* bis bifidus; *stigmata* 4, parva. *Calyx fructifer* maxime auctus, oblongus, vesicæformis, submembranaceus, 5-plicatus, angulis nervosis in dentibus 5 parvis os stringentibus terminatus: *drupa* quater brevior, inclusa, oblonga, nitida, disco stipitata, stylo longe apiculata, monopyrena; *pyren* ovatus, rostratus, osseus, summo 4-locularis, imo in cruribus 4 protensus, interstitiis et centro cavato medulla repletis, loculos alteros fingentibus. *Semina* in quoque loculo solitaria, conice ovata, erecta: *integumenta* alba, tenuissima; *embryo* exalbuminosus, atropus; *radicula* parva supera, obtusa; *cotyledones* 2, magnæ, pluriseriatim longitudinaliter plicatæ.

Arbuscula *Peruviana, frondosa*: folia *alterna, lanceolata, petiolata*: panicula *supraaxillaris, dichotome ramosa*; flores *minimi*.

1. Sacellium lanceolatum, Humb. & Bonp. Pl. Æquin. i. 47, tab. 13; Lam. Dict. Suppl. v. 10, tab. 995; H., B. & K. vii. 207; DC. Prodr. ix. 502: arbuscula ramosissima, foliis lanceolatis, utrinque acutis, summum versus remote dentatis, submembranaceis, nervoso-reticulatis, supra hirtellis, subtus pallidioribus, molliter pubescentibus, costa nervisque prominulis; petiolo tereti, canaliculato, pubescente, limbo 15–18plo breviore: panicula supraaxillari, folio ter breviore, dichotome ramosa, pubescente; floribus parvis, subcrebris, brevissime pedicellatis; calyce fructifero valde aucto, acute ovato, reticulato-nervoso, membranaceo, pentagono, 5-plicato: drupa 6plo breviore ovata, rostrata: cæt. ut in char. gen. In Peruvia alta, ad fluv. Guancabamba prope Loxam (*non vidi*).

This is described as a tree 9–12 feet high, with a copiously frondose head, and a trunk with white wood, 1 foot in diameter. The axils are about $\frac{3}{4}$ in. apart; the leaves are

about 6 in. long, 14–15 lines broad, on petioles 4–5 lines long; the flowing panicle issues at a point 1 or 2 lines above the axil, is 2¼ in. long; the calyx is 1 line long, the corolla very little longer; the fructiferous calyx is membranaceous, reticulated, of a straw-colour, about 1 inch long, 7 lines broad, encloses a drupe 3 lines long, of a blackish brown colour, and polished.

3. Hymenesthes.

This genus is proposed for a plant collected in Cuba by Wright, and named "*Bourreria succulenta,* Jacq." by Dr. Grisebach, who regarded it as the flowering specimen of another plant to which he gave the same name, both having been distributed, with tickets thus denominated, under Wright's number 3119, as they appear in the herbaria of the British Museum and that of Kew. The latter plant is certainly named in error, and has been described by me as *Bourreria clariuscula* *; the former plant does not even belong to that genus †, nor to the same family, thus adding another to the many misnomers already specified in Dr. Grisebach's enumeration of Wright's Cuban plants. The structure of the flower in the plant in question differs extremely from that of *Bourreria,* and approaches that of *Patagonula.* The flowers are small; the calyx and corolla are of extremely thin texture and transparent; the tube of the latter is as long as the calyx, its border, of the same length, is divided into 5 linear-oblong segments, which are deeply introflexed and connivent over the stamens; the exserted anthers stand upon equal subulate filaments, pilose below, and inserted near the base of the tube; the ovary, style, and stigma as in the preceding genera. As all the flowers are in a young state, we have no indication of the growth of the calyx or the structure of the fruit. The genus differs from *Patagonula* in the longer tube of the corolla, in the variable number of its parts, and other particulars. Its name is derived from ὑμὴν, *membrana,* ἐσθὴς, *vestis.*

Hymenesthes, nob.

Calyx campanulatus, textura tenui, ore 3- vel 4-dentatus, dentibus rotundatis. *Corolla* tubulosa, tenuissime membranacea, tubo turbinato, calyci æquilonga, limbi lobis 4–5–6, oblongo-acuminatis, marginibus crenulato-sinuatis, valde reflexis, in æstivatione profunde introflexis et centro conniventibus. *Stamina* numero loborum, iis alterna, exserta; *filamenta* subulato-filiformia, imo compressa, patentim hirsuta, superne glabra, infra medium tubi inserta; *antheræ* ovatæ, 2-lobæ, utrinque rima laterali dehiscentes. *Ovarium* conicum, *disco* magno cylindrico continuum, 4-loculare; *ovula* in loculis solitaria, e basi erecta, atropa. *Stylus* subbrevis, fere ad basin bifidus, ramis paullo divergentibus, iterum fissis; *stigmata* 4, parva, compressa. *Cæt.* ignota.

Suffrutex *Cubensis, glaberrimus*: folia *alterna, obovata, nitida, petiolata*: panicula *terminalis, dichotome divisa*; flores *parvi.*

1. Hymenesthes nitida, nob.: *Bourreria succulenta* in parte, Griseb. (non Jacq.), Cat. Pl. Cub. 209: ramulis teretibus, subrugulosis; foliis obovatis, imo ad medium sensim attenuatis, apice rotundatis aut emarginatis, crassiusculis, utrinque glaberrimis, supra nitidis, læte viridibus, valde reticulatis, subtus pallidioribus, nervis venisque prominulis; petiolo subtenui, limbo 6plo breviore: paniculis terminalibus

* Contrib. Bot. ii. 235.

† Ibid. p. 233.

dichotome multidivisis, ramis tenuibus, glabris: floribus parvis, cum pedicellis brevissimis articulatis; calyce 3-dentato; corolla tenuissime membranacea, limbi lobis et staminibus inconstantibus, extus obsolete puberula. In Antillis: *v. s. in hb. Mus. Brit. et Hook.* ins. Cuba (*Wright* 3119, sub nom. *Bourreria succulenta*).

The leaves are $1\frac{1}{2}$–$2\frac{1}{4}$ in. long, 1–$1\frac{1}{4}$ in. broad, on petioles 3–4 lines long; the panicle is $1\frac{1}{2}$ in. long; the calyx is 2 lines long, $1\frac{3}{4}$ line broad; the tube of the very transparent corolla, as well as its lobes, are of the same length; the lobes in the flowers of the same panicle, as well as the stamens, vary in number from 4 to 6, the rounded teeth of the calyx being constantly 3.

4. PATAGONULA.

The typical species of this genus was first made known by Dr. Dillen in 1732, who described it from a cultivated plant raised in Dr. Sherard's garden at Eltham, and figured by him in his Hort. Elthamensis. After the fashion of that period, he called it simply *Patagonica*, because he learned it had been introduced from Patagonia. No original specimen of the plant has ever been obtained, so that its exact locality is not known. It must be remembered that the date of Dillen's plant is 36 years prior to Captain Cook's first voyage with Dr. Solander, who was the first regular botanist to explore the Tierra del Fuego and the Straight of Magellan. We must therefore look back to the days of Dampier, who visited the coasts of Patagonia several times between 1700 and 1720, and who, it is known, had a taste for botany, and collected plants and seeds in the course of his numerous voyages. At that time, and for nearly a century afterwards, the shores of the whole of the South American continent remained utterly inaccessible to European search; and it is, therefore, with the greatest probability that we may assign the original source of the plant cultivated in Sherard's garden to the seeds brought home by Dampier from Patagonia, perhaps Tierra del Fuego. We know that a kindred species was obtained in 1820 by Sello, in South Brazil, and described in 1829 by Chamisso; but that is a far more glabrous plant, with narrower leaves, and is certainly very distinct. *Patagonula*, as a genus, was first established by Linnæus in 1787, who gave it that substantive name in lieu of Dillen's adjective prefix. It was also enumerated in Aiton's 'Hortus Kewensis' in 1789, under the name of *Cordia Patagonula*. Jussieu, in 1789, placed *Patagonula* near *Cordia*; Endlicher (1838) considered it a doubtful genus; and DeCandolle (in 1856) excluded it from the family without assigning to it another position. Prof. A. DeCandolle was of the same opinion, because he had observed its erect ovules in Blanchet's specimen from Bahia, on which account he was disposed to refer the genus to the Verbenaceæ. This opinion was not supported by Schauer, who soon afterwards composed his monograph of the latter family for the Prodromus. Fresenius, in 1857, in the 'Flora Brasiliensis,' placed *Patagonula* in the *Cordiaceæ* without hesitation, though he does not seem to have examined it. It appears that no one has taken the trouble to inquire into the subject; and I therefore give the following diagnosis, founded upon my own analysis.

PATAGONULA, Linn.; *Patagonica*, Dill.

Calyx parvus, fere ad basin 5-partitus, laciniis æqualibus, demum in fructu valde auctis. *Corolla* tubulosa, tubo calycem æquante subcampanulato, subplicatim 5-sulcato, limbi laciniis 5, ovatis, obtusis, expansis, in æstivatione apicibus incurvis centro conniventibus. Stamina 5, laciniis alterna; *filamenta* filiformia, imo latiora, supra basin tubi inserta, exserta; *antheræ* ovatæ, 2-lobæ, introrsæ, medio dorsi affixæ, longitudinaliter dehiscentes. *Ovarium* superum, conice ovatum, *disco* 4-lobo insitum, 4-loculare, ovulis in quoque loculo solitariis, e basi erectis, atropis. *Stylus* bis bifidus; *stigmata* 4, parva, subclavata. *Drupa* parva, exsucca, ovato-globosa, stylo apiculata, calyce valde aucto subcoriaceo nitido stellatim dilatato circumdata, monopyrena; *pyren* subglobosus, imo breviter stipitatus, apice rostratus, osseus, 4-locularis, loculis 2 sæpe abortivis: *semen* conico-oblongum, apice micropylo notatum, ad basin angulum versus hilo cum *chalaza* subconfuso affixum; *integumenta* 2, tenuia, albida, *raphe* nulla; *embryo* exalbuminosus, *radicula* tereti, supera, *cotyledonibus* 2 longitudinaliter multiplicatis multo breviore.

Arbusculæ *Americæ meridionalis, ramosissimæ:* folia *elliptica vel lanceolato-oblonga, glabra aut pilosula, sæpe dentata, petiolata:* paniculæ *axillares vel terminales, dichotome multidivisæ, sæpe pubescentes, ramis tenuissimis;* flores *parvi, ebracteati.*

1. PATAGONULA AMERICANA, Linn. Gen. Pl. (1737) p. 45; Poir. Dict. v. 57; Lam. Illust. 424. n. 1915, tab. 96; Cham. in Linn. iv. 492; Fres. in Mart. Fl. Br. fasc. xix. p. 27: *Patagonica*, Dill. Elth. (1732), p. 304, tab. 226. f. 293: *Cordia Patagonula*, Dryand. in Ait. Hort. Kew. i. 259: *Petræa dentata*, Spr. Sys. ii. p. 76: ramosissima, ramis teretibus, tenuibus, striatis, lenticellis albidis rugulosis, patentim longe rufo-hirtulis, rarius demum subglabris, in axillis præsertim hirtis; foliis alternis, interdum binis, oblongo-ellipticis, aut lanceolato-oblongis, imo angustioribus, apice obtusis vel subacutis, sæpius remote grosse serratis, marginibus nervigeris plus minusve ciliatis, submembranaceis, valde reticulatis, utrinque glabris, supra pallide viridibus, in costa nervisque sulcatis, subtus pallidioribus, costa nervisque prominulis, in junioribus minute pellucido-punctatis; petiolo tenui, canaliculato, limbo 15–20plo breviore: paniculis axillaribus et terminalibus, dichotome multidivisis, ramis tenuibus, rugulosis, hirsutis; floribus parvis, pedicellatis; calyce pallide membranaceo, fere ad basin 5-fido, lobis oblongis, erectis, extus glandulis fuscis piliferis punctatis, margine longe ciliatis; corolla glabra, tubo campanulato, calycem æquante, laciniis 5 æquilongis, acute ovatis, expansis, minute pellucido-punctatis; staminibus imo insertis, exsertis; ovario glabro, subconico, 4-loculari; stylo bis bifido: drupa parva, apiculata, calyce valde aucto circumdata, laciniis spathulato-oblongis, emarginatis, reticulatis, radiatim expansis. In Patagonia: *v. s. in hb. Mus. Brit.* ex hb. Mill. in hort. Warner. cult.

This species is well distinguished from *P. glabra*, which has been confounded with it, by its larger, more membranaceous, more deeply dentate leaves, hispid branchlets, and many other characters. The axils of its branches are $\frac{1}{2}$–$\frac{3}{4}$ in. apart; the leaves are 2–2$\frac{3}{4}$ in. long, $\frac{3}{4}$–1$\frac{1}{2}$ in. broad, on slender petioles 2 lines long. The panicles are 1–1$\frac{1}{2}$ in. long; the pedicels $\frac{1}{2}$ line long; the calyx 1 line long; the tube of the corolla and segments each 1 line; the lobes of the fructiferous calyx, according to Dillen, are 6 lines long, 2 lines broad.

2. Patagonula glabra, nob.: *Patagonula Americana*, var. *glabra*, Cham. Linn. iv. 492; Fresen. in Mart. Fl. Br. *l. c.* p. 27, tab. 9. fig. 9: ramosissima, ramis tenuibus, striolatis, lenticellato-rugulosis, glabris: foliis lanceolato-oblongis, imo subcuneatis, apice obtusis aut subacutis, junioribus lineari-lanceolatis, summum versus remote dentatis, marginibus revolutis, subcoriaceis, impunctatis, opacis, utrinque glaberrimis, supra viridibus, subtus pallide glaucis, costa nervisque prominulis, venis tenuissime reticulatis, interstitiis elevatis, hinc quasi punctato-granulatis; petiolo tenui, supra plano, limbo 12–15plo breviore: paniculis axillaribus et terminalibus dichotome multidivisis, glabris, raro obsolete pilosulis; floribus parvis, pedicellatis; calyce 5-partito, lobis oblongis, obtusis, extus pilis articulatis puberulis, apice pilis simplicibus ciliatis; corollæ tubo calycem æquante, campanulato, extus glabro, intus scabridule pruinoso, limbi lobis 5, ovatis, tubo æquilongis, expansis; staminibus 5, in tubi basin insertis, ultra faucem vix exsertis, glabris; ovario conico, disco 4-lobo imposito, 4-loculari; stylo bis bifido: drupa parva, conice globosa, imo stipitata, apice apiculata, calyce demum magnopere aucto circumdata, laciniis spathulato-oblongis vel lineari-oblongis, reticulatis, pellucido-punctulatis, glaberrimis, radiatim expansis. In Brasilia, prov. Rio Grande do Sul: *v. s. in herb. Mus. Brit. et Hook.* Encrucilhado, Rio S. Barbara (*Sellow*).

Sellow's plant was considered by Chamisso a mere variety of the typical species, which he had never seen; but it differs widely in its much smaller, more coriaceous leaves and other characters.

It forms a tree of moderate size, furnishing a useful timber of a yellowish white colour, called *Ipé branco*. Its slender branchlets are quite glabrous, a few hairs being sometimes seen on the axillary bud; the axils are $\frac{1}{4}$–$\frac{1}{2}$ in. apart; the leaves, which Chamisso compares to those of the Laurel, are $1\frac{1}{2}$–$2\frac{1}{4}$ in. long, 7–12 lines broad, on petioles $1\frac{1}{2}$–2 lines long: from their opaque texture they form a great contrast to the submembranaceous leaves of the preceding species. The panicles, which have slender ramifications, are almost glabrous, about 2 in. long; the calyx is said by Fresenius to be covered with glanduliferous hairs. I found the corolla persistent at the base of the free drupe; it has a campanular tube 1 line long, with lobes of equal length; the filaments are not fixed in the throat, as Chamisso states, but near the base of the tube. The fructiferous calyx has 5 spathulate lobes 10–11 lines long, $1\frac{1}{2}$–2 lines broad, with a central stipitate drupe 2 lines long and 1 line broad.

3. Patagonula Tweediana, nob.: ramulis tenuibus, angulato-striatis, glabris: foliis glaberrimis, lanceolatis vel lanceolato-oblongis, imo cuneatis et integris, a medio sursum gradatim acutis et crenulato-dentatis, chartaceis, supra viridibus, nitidis, costa flavida complanata, tenuiter nervosis, granulato-punctatis, subtus pallidioribus, nervis tenuissimis immersis, creberrime flavido-maculatis; petiolo tenui, subplano, limbo 12–15plo breviore: paniculis axillaribus dichotome divisis, floribus parvis in ultimis sectionibus glomerulatis; calyce 4-partito; corollæ glabræ tubo brevi subcampanulato, limbi laciniis 4, oblongis, obtusis, extus obsolete puberulis; filamentis tenuissimis 4, paullo sub faucem insertis, longe exsertis, sparse pilosulis:

drupa conice globosa, parva, imo brevissime stipitata et bifossata, apice rostrata, corolla persistente cincta et calyce valde aucto 4-lobo circumdata, 4-loculari (loculis 2 subabortivis); seminibus generis. In Brasilia prov. Rio Grande do Sul: *v. s. in hb. Hook.* Viamaõ (*Tweedie*, 27).

Tweedie describes this as a "fine tree," growing in the woods of Viamaõ, about 10 miles E. of Port Alegre, and 30 miles from the locality of the preceding species. It is distinguished from the latter by its more lanceolate leaves, by its glomerulate flowers, which are constantly 4-merous, by the insertion of its stamens, its hairy filaments, and the presence of 4 augmented calycine lobes around the fruit. The branches are slender, with axils $\frac{1}{2}$ in. apart; the leaves are $2\frac{3}{4}$–3 in. long, 8–10 lines broad, on petioles $2\frac{1}{2}$ lines long; the tube of the corolla is 1 line long, its lobes of the same length; the 4 patent segments of the augmented calyx are 10 lines long, $2\frac{1}{2}$–3 lines broad; the exsuccous drupe is 3 lines long, 2 lines broad, is shortly stipitate at the base, with 2 hollow cavities; the nut, somewhat fibrous in texture, has 2 larger cells, bearing each an erect seed, terminated by the micropyle, and fixed by its base to the bottom angle of the cell, with a basal chalaza, no raphe being visible.

4. Patagonula bahiensis, Moric. Pl. Amer. tab. 86; A. DC. Prodr. ix. 467, in not.; Fresen. in Fl. Br. *l. c.* p. 28: ramulis fuscis, lenticellis albis rugulosis, glanduloso-tomentosis: foliis alternis, vel 2–3 approximatis, ovato-ellipticis, utrinque subacutulis, imo circa petiolum brevissimum subito rotundiusculis, acumine obtusiusculo, fere integris, aut in marginibus cartilagineis crenulatis obsolete denticulatis, supra sublucidis, fere glabris, costa nervisque subimmersis hirtellis, subtus pallidis, opacis, dense puberulis atque setaceo-hirsutulis, costa nervisque prominulis; petiolo semitereti, setaceo-piloso, limbo 40plo breviore: paniculis axillaribus et terminalibus, tenuiter dichotome multidivisis, pubescentibus; floribus parvis, subsessilibus; calyce 5-partito, lobis oblongis, acutis, extus glanduloso-setaceo hirsutulis, margine ciliatis; corolla membranacea, minute pellucido-punctata, tubo subcampanulato, calycem æquante, limbi lobis 5, ovato-ellipticis, obtusis, subreflexis, margine ciliatis; staminibus 5, imo insertis, vix exsertis, glabris; ovario semigloboso, disco insito, 4-loculari; stylo bis bifido. In Brasilia, prov. Bahia: *v. s. in hb. Hook.* Jacobina (*Blanchet*, 3086).

Besides the above cited, DeCandolle quotes others of Blanchet's numbers (2855 and 3902) among his specimens. The axils of its branchlets are 1–$1\frac{1}{2}$ in. apart; the leaves 3–$3\frac{1}{2}$ in. long, 1–$1\frac{3}{4}$ in. broad, on petioles 1 line long; the panicle is $2\frac{3}{4}$ in. long and broad; several flowers are agglomerated at the end of its branchlets into a head 3 lines in diam.; the flower expanded is 2 lines broad, the calycine lobes $\frac{3}{4}$ line long; these expand in the fruit to a length of 9 lines and breadth of 2 lines, nerved and reticulated; the fruit as in the preceding species.

5. Paradigma.

This genus is proposed for a plant from the island of Cuba, insufficiently described many years ago by Richard as a species of *Cordia*. The general structure of the flower and fruit, the peculiar æstivation of the corolla, its numerous lobes, its sessile linear

anthers, its stigmata, the position of its ovules, and the enlargement of the calyx around the fruit, all prove it to be very different from *Cordia*. It is evidently allied to *Auxemma*, differing in its much larger corolla, in its more coriaceous calycine envelope of the fruit, the structure of which is similar to that of the genus last mentioned. The name given to it is derived from παράδειγμα, *exemplar*, as it offers a striking example of the peculiar characters which distinguish *Auxemma*.

PARADIGMA, nob.

Flores hermaphroditi. *Calyx* ovato-tubulosus, coriaceus, primum omnino clausus, tunc in dentibus brevibus sæpius 3, rotundatis irregularibus margine dense ciliatis apertus, demum accrescens et persistens. *Corolla* majuscula, tubulosa, *tubo* carnosulo, pro dimidia parte inferiore anguste cylindrico et calycem æquante, seorsum subito infundibuliformi, *fauce* campanulata, crebre parallele nervosa, *limbo* 8-lobo, lobis oblongis, acutis, demum expansis, æstivatione tubo multiplicato lobis profunde introflexis et in centro conniventibus. *Stamina* 8, lobis alterna, sub faucem inclusa; *filamenta* nulla; *antheræ* æquales, lineares, intra faucem sessiles, tubo ter breviores, 2-lobæ, lobis connectivo angusto membranaceo supra medium nexis, imo segregatis et ad sinum affixis, utrinque lateraliter dehiscentibus; *pollen* globosum, reticulatum. *Ovarium* superum, oblongum, *disco* parvo insitum, 4-loculare; *ovula* in loculis solitaria, erecta, atropa; *stylus* filiformis, bis bifidus; *stigmata* 4, inclusa, majuscula, lineari-lamelliformia, marginibus anguste membranaceis et crenulato-undulatis. *Drupa* majuscula, exsucca, oblonga, apiculata, calyce coriaceo aucto ore dentato occlusa, monopyrena; *pyren* ovatus, apice conico-acutus, lateribus sulcis irregularibus et interruptis sarcocarpio repletis profunde exsculptus, dense osseus, cavitate centrali ampla excavatus, et hinc materia fibrosa vasis repleta e disco enata munitus, superne 4-locularis, loculis monospermis (uno alterove minore) ad basin pro vasorum introitu perforatis. *Semen* loculum implens, oblongo-ovatum, ad basin prope ab angulo affixum: *integumenta* 2, *externum* album, friabile, *internum* crassiusculum, opacum; *raphe* nulla; *chalaza* cum hilo basali confusa; *embryo* exalbuminosus, atropus; *radicula* supera, parva; *cotyledones* 2, carnosulæ, plurifariam longitudinaliter plicatæ.

Arbor *Antillana, ramosissima*: folia *alterna, ovata, integra, petiolata*: paniculæ *terminales, dichotome divisæ*; flores *majusculi, speciosi.*

1. PARADIGMA GALEOTTIANA, nob.: *Cordia Galeottiana*, A. Rich. in Flor. Cub. Sagr. xi. 109; Griseb. Pl. Cub. 208; Walp. Ann. v. 540: ramis glabris, substriatis: foliis glaberrimis, ovalibus vel oblongis, apice breviter constrictis obtusis et canaliculatis, imo obtusis, coriaceis, integris, supra opace viridibus, costa nervisque tenuibus submmersis, subtus pallidioribus, nervis patentibus rubellis paullo prominentibus; petiolo supra sulcato, limbo 6plo breviore: paniculis terminalibus, dichotome multiramosis, glabris, ramulis compressis, ultimis 1–2-floris, bracteis lineari-acutis valde deciduis; calyce tubuloso, coriaceo, glabro, intus parallele multinervoso, apice primum clauso, dein aperto, dentibus 3–6 rotundatis, ciliatis, extus obsolete, intus densius pilosis; corolla infundibuliformi, tubo calyce 2plo longiore, imo angustato, glabro, superne ad nervos 24 prominulos pilosulos plicato, limbo expanso, lobis 8, lanceolato-oblongis, acutis, submembranaceis, extus dense cano-tomentosis; antheris intra faucem affixis, 8, linearibus, sessilibus: ovario subulato-oblongo, striato: drupa oblonga, apiculata, calyce aucto ore contracto tecta, exsucca; pyrene 4-loculari, 4-spermo. In Antillis: *v. s. in hb. Mus. Brit.* Cuba circa Havanna (*Galeotti*, 19).

The axils of this plant are about $\frac{3}{4}$ in. apart; the leaves are $2\frac{1}{2}$–4 in. long, $1\frac{1}{4}$–$1\frac{7}{8}$ in. broad, on petioles 5–8 lines long, with about 10 pairs of slender patently divaricate nerves; the panicle is 2 in. long; the calyx in flower 5 lines long, 3 lines broad; the tube of the corolla is $1\frac{1}{8}$ in. long, $1\frac{1}{2}$ line broad at the base for a length of 5 lines, thence gradually widening to a breadth of 9 lines at the mouth; the lobes are 6 lines long; the anthers 3 lines long, 1 line broad; the conical ovary is 2 lines long, $\frac{1}{2}$ line broad; the subulate style 3 lines long, its branches 2 lines; the stigmata 2 lines long; the enlarged calyx concealing the fruit is 9 lines long, 7 lines broad; the oval drupe, attenuated at its summit, is 9 lines long, 6 lines broad; nut deeply furrowed, has a deep hollow along its axis, and has 4 basal cavities at its base filled with pithy matter, as in *Auxemma.*

6. Plethostephia.

This genus is proposed for another of Richard's Cuba plants, his *Cordia angiosperma*, which differs from that genus in its large salver-shaped corolla, with a rotate border of 15 lobes, with their margins overlapping one another dextrorsely, in its 10 included stamens in 2 unequal series, its 10-lobed hypogynous disk supporting a 4-celled ovary. The calyx is tubular, and 5-toothed, becoming thicker and enveloping the fruit as in the preceding genus. As I have not seen any specimen, the generic character is founded wholly on Richard's description and figures. Its name is derived from πλῆθος, *multitudo*, στέφω *corono*, because of the many-lobed border which crowns the corolla.

Plethostephia, nob., *Cordiæ* sp., Rich.

Calyx tubulosus, margine 5-dentatus, persistens et augescens. *Corolla* subhypocrateriformis, tubo calyce 3–4plo longiore, imo cylindrico, sursum anguste infundibuliformi, fauce nuda, *limbo* patentissimo, tubo 5plo breviore, in lacinias 15 diviso, *laciniis* recte oblongis, acutis, marginibus (sec. icon.) dextrorsum imbricantibus. *Stamina* 10, inæqualia, alternatim biseriata, inclusa; *filamenta* subbrevia, teretia, erecta, supra medium tubi inserta; *antheræ* ovatæ, filamento ter breviores, 2-lobæ, lobis adnatis introrsum dehiscentibus. *Discus* hypogynus, pulvinatus, crenatim 10-lobus: *ovarium* superum, oblongum, disco insitum, 4-loculare; *ovula* in quoque loculo solitaria, erecta, atropa; *stylus* filiformis, corollæ tubo æquilongus, apice 4-fidus, laciniis recurvis; *stigmata* 4, parva, capitata. *Drupa* conice ovata, carnosa, imo stipitata, stylo immutato recurvo apiculata, calyce aucto incrassato occulta, monopyrena; *pyren* osseus, acute ovatus, imo disco stipitatus, summo apiculatus, extus sulcis profundis exsculptus, abortu 2-locularis; *semen* in quoque loculo unicum, basi stipitato-affixum, erectum.

Arbor *Antillana, ramosa:* folia *coriacea, late ovata, undulato-crenata, petiolata:* paniculæ *terminales, dichotome divisæ;* flores *pedicellati, speciosi.*

1. Plethostephia angiocarpa, nob.: *Cordia angiocarpa*, A. Rich. in Fl. Cub. Sagr. 119, tab. 60; Walp. Ann. v. 540: ramulis validiusculis hirsutissimis: foliis in apice ramorum subconfertis, late ovalibus aut suborbicularibus, imo obtusis et in petiolum breviter acutatis, apice rotundatis, integris, vel ad margines subundulato-sinuatis, nervis utrinque 6 divergentibus, venis parallele transversis, utrinque hirto-scaberrimis; petiolo late sulcato, limbo 7plo breviore: panicula terminali, brevissime pedunculata, quater dichotome divisa, ferrugineo-hirta; floribus spe-

ciosis, pedicellatis; calyce tubuloso breviter 4-dentato, pedicello 3plo longiore, ferrugineo-hirto, demum in fructu aucto; corollæ tubo calyce 3plo longiore, striato, hirto, limbi rotati laciniis 14–15, oblongis, acutis; staminibus 10, omnino inclusis, supra medium tubi insertis; ovario ovato, disco insito; stylo tenui corollæ longitudine: drupa oblonga, acuta, subcarnosa, imo disco crasso stipitata, apice stylo recurvulo apiculata, calyce aucto incrassato inclusa; pyrene valde exsculpto abortu 2-loculari, loculis monospermis. In Ins. Cuba (*non vidi*).

Its stout branchlets have their axils 3–4 lines apart; the leaves are $3\frac{1}{4}$–5 in. long, $2\frac{1}{4}$–3 in. broad, on petioles 9–11 lines long; the panicle is $3\frac{1}{2}$ in. long, the peduncle 2 lines long, the ramifications 4 lines long, the ultimate pedicels 2 lines long; the calyx is 5–7 lines long, 3 lines broad; tube of corolla $1\frac{3}{4}$ in. long, contracted at its base for the length of 5 lines, where it is 2 lines broad, gradually enlarging towards the mouth, which is 6 lines broad; the horizontally expanded segments of the border are equally 4 lines long. 2 lines broad; the filaments are inserted about 2 lines above the middle of the tube alternately a little above the others; the filaments $2\frac{1}{2}$ lines long, the anthers $1\frac{1}{2}$ line long; the ovary 2 lines long, on a disk 1 line high; the style 17 lines long, its 4 recurved branches 2–3 lines long; the enlarged calyx is 12 lines long, encloses a drupe, which, with its discal support, is 10 lines long, 5 lines broad. A drawing of this plant, with its analytical details, copied from Richard's figures, is given in Plate VIII. of the present memoir.

DESCRIPTION OF THE PLATES.

Plate V.

Shows a branchlet of *Auxemma Gardneriana*, with its dichotomously divided panicle of small flowers.

Fig. 1. A flower.
2. The calyx and corolla, seen separately: *all nat. size.*
3. The calyx: *magnified.*
4. The tubular corolla, with its segments inflected in æstivation.
5. The same, after expansion, when the segments become reflected.
6. The same, cut open to show the position of the stamens.
7. The five unequal stamens, shown separately: *all equally magnified.*
8. The same: *more magnified.*
9. The ovary seated on the hypogynous disk, with the style and stigmata.
10. A longitudinal section of the same.
11. A transverse section of the 4-celled ovary: *all equally magnified.*
12. The persistent calyx, now grown to 30 times its former length, becoming a reticulated bladder-like envelope, deeply 5-angled, narrowed by 5 teeth in the mouth, and deeply cordate at the base.
13. The same, with a portion cut away to show the enclosed drupe.
14. The same, with half of the calyx cut away transversely, showing its angular form around the enclosed drupe.

Fig. 15. The fleshy drupe, shown separately.

16. Half of the pericarp of the same removed, showing the enclosed muricated osseous nut.
17. The nut cleared of all the pericarp, when its four basal fangs are seen round the hollow base.
18. A longitudinal section of the same, showing an erect seed in each cell, attached at its base by a broad hilum, into which the nourishing vessels from the basal cavity pass through distinct perforations.
19. A transverse section of the nut, with its 4 cells, each containing a single erect seed.
20. One of the seeds: *all nat. size.*
21. The same, with the integument removed, leaving the exalbuminous embryo, consisting of a small superior radicle and 2 very plicated cotyledons.
22. The same, seen from above: *both magnified.*

Plate VI.

Section A. Shows a branch of *Sacellium lanceolatum*, in flower and fruit: copied from the drawing of Bonpland.

Fig. 1. A flower: *nat. size.*

2. The calyx: *magnified.*
3. The corolla.
4. The same, cut open, to show the position of its 5 equal stamens.
5. The ovary seated on a fleshy disk, surmounted by the style and stigmata: *all equally magnified.*
6. The much enlarged vesicoid calyx, contracted in the mouth by 5 teeth, and surrounding the drupe fixed at its base.
7. The same, with half of the calyx cut away, showing the drupe placed in the centre, as viewed from above.
8. The drupe removed, apiculated by the style, and seated on the stipitiform disk.
9. A longitudinal section of its enclosed osseous nut, showing in its upper portion 2 of its 4 cells, each with an erect seed: the lower portion is hollow between 4 descending fangs (as in *Auxemma*); and it was this hollow part which Bonpland mistook for 4 sterile cells.
10. A transverse section of the same, across the 4 equal cells.
11. One of the seeds, with a broad basal hilum: *all nat. size.*
12. The embryo, deprived of its integument, formed like that of *Auxemma*, with a small superior radicle, and 2 very plicated cotyledons.
13. The same, as seen from above: *both magnified.*

Section B. A branchlet of *Hymenesthes nitida* in flower.

Fig. 1. A flower: *nat. size.*

2. The calyx.
3. The corolla, with its segments inflected in æstivation.
4. The same, after expansion.
5. The same cut open, to show the position of the stamens.
6. The ovary, disk, style, and stigma: *all equally magnified.*
7. The stamens, seen in different positions.
8. The ovary, seated on the disk, surmounted by the style and stigma.
9. A longitudinal section of the same, showing 2 of its 4 cells.
10. A transverse section of the same, showing its 4 cells: *all more magnified.*

Plate VII.

Section A. shows a branchlet of *Patagonula bahiensis* with its dichotomously divided panicle.

Fig. 1. A flower: *nat. size.*
2. The same: *magnified.*
3. The calyx.
4. The corolla.
5. The same, cut open to show the position of the stamens.
6. The ovary upon the disk, with the style and stigma: *all magnified on the same scale.*
7. Three of the stamens before and after dehiscence: *more magnified.*
8. The fruit, surrounded by the 5 persistent lobes of the calyx, now greatly enlarged and horizontally expanded: *nat. size.*

Section B. A branch of *Patagonula Tweediana*, with its dichotomous panicle in fruit.

Fig. 1. A persistent flower found at the base of one of the fruits: *nat. size.*
2. The same *magnified*, and cut open, to show the position of its 4 stamens, alternate with 4 segments.
3. The stamens shown separately: *also magnified.*
4. A drupe surrounded by the 4 persistent, and now much enlarged, lobes of the calyx.
5. The dry drupe detached: *both nat. size.*
6. The same, with part of the calycine lobes: *magnified.*
7. The same detached, and supported by the stipitate disk.
8. The same viewed from below, to show the two basal hollows.
9. A longitudinal section of the same showing in each cell an erect seed, fixed at its base, where the nourishing vessels, proceeding from the torus, perforate the nut, to reach the hilum.
10. A transverse section of the same, showing 2 fertile and 2 sterile cells.
11. One of the erect seeds, the chalaza confounded with the basal hilum: *all magnified on the same scale.*
12. The same enlarged.
13. The same, with its integument removed, exposing the exalbuminous embryo, like that of *Auxemma.*
14. The same viewed from above: *all more magnified.*

Plate VIII.

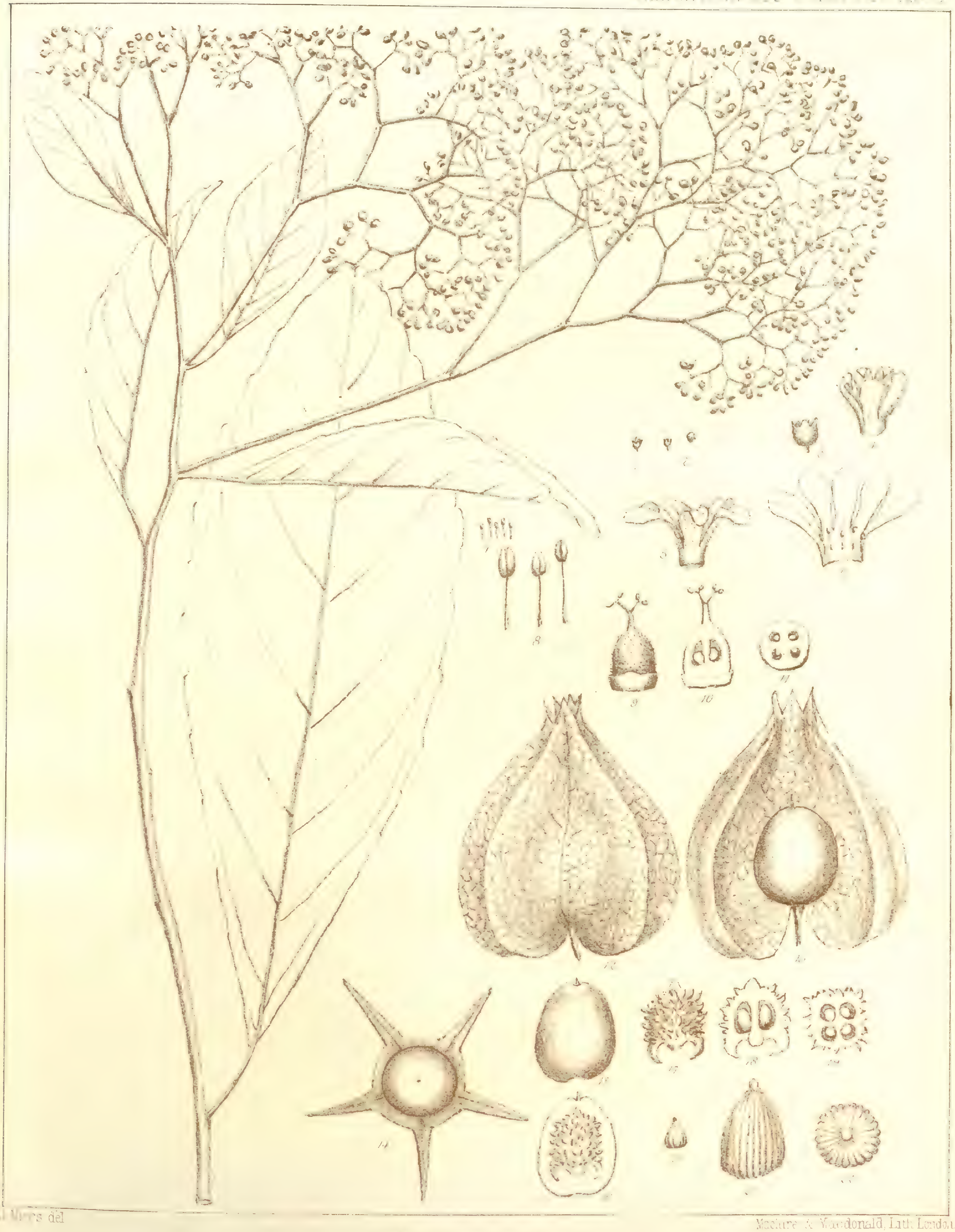
Section A. A branch of *Paradigma Galleottiana*, with its dichotomous corymb, drawn from an original specimen collected by Galleotti.

Fig. 1. A flower in bud.
2. The calyx.
3. The corolla beginning to open.
4. The same cut open, showing how the 8 segments are inflected in æstivation, and the relative position of the 8 stamens. The corolla, fully grown and expanded, is seen in the drawing of the plant.
5. The ovary, disk, style, and stigmata: *all nat. size.*
6. The same: *magnified.*

7. One of the sessile stamens, formed of 2 linear anther-cells, connected by a shorter intermediate membranaceous connective, attached at its sinus to the corolla : *more magnified.*
8. One of the 4 compressed linear stigmata, cinctured by an undulating membrane : *much magnified.*
9. The persistent calyx, now much enlarged, and enclosing the drupe.
10. The fleshy drupe removed.
11. The fleshy pericarp of the same taken away, leaving a deep foveolated osseous nut.
12. A transverse section of the nut, showing 2 fertile and 2 sterile cells, placed round the hollow axis.
13. A longitudinal section of the same, showing the hollow axis and the 2 fertile cells, each with an erect seed fixed at its base : *all nat. size.*
14. A *magnified* view of the same, showing the nourishing vessels, ascending from the torus, and perforating the nut, to reach the chalazal point of attachment of each seed.
15. The erect seed, separated.
16. The same, deprived of its integuments, leaving an exalbuminous embryo, like that of *Auxemma* : *both magnified.*

Section B. Portion of a branch of *Plethostephia angiocarpa*, with its dichotomous panicle : copied from Richard's drawing.

Fig. 1. A flower.
2. The calyx.
3. Half of the corolla laid open, showing 8 of its 15 segments, and 5 of its 10 stamens, in 2 series.
4. The calyx half cut away, to show the enclosed ovary upon its disk, and surmounted by the style and stigmata : *all nat. size.*
5. A longitudinal section of the ovary and disk, showing an erect ovule in each cell.
6. A transverse section of the same, showing its 4 cells : *both magnified.*
7. The persistent calyx, now much increased, and enclosing an oval drupe.
8. The drupe with the fleshy pericarp removed, leaving an osseous foveolated nut, apiculated by the style.
9. A transverse section of the same, showing 2 fertile and 2 abortive cells : *all nat. size.*
10. A longitudinal section of the same : *magnified.*



J. Miers del.

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AUXEMMA GARDNERIANA.

J. Miers, del.

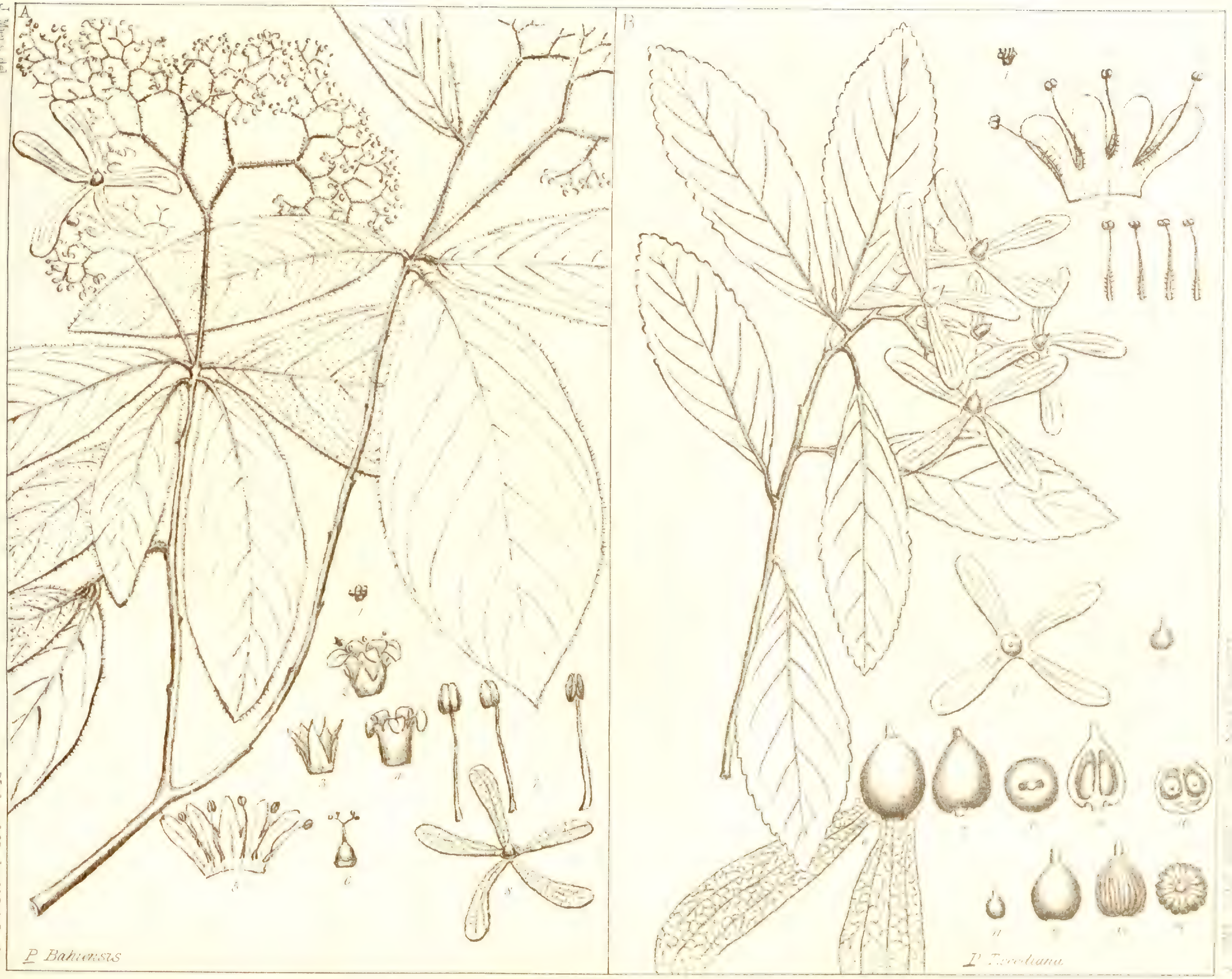
SACELLIUM-LANCEOLATUM.

HYMENESTHES-NITIDA.

Maclure & Macdonald. Lith. London.

Bot. Tab. 6.

J. Miers del.



Maclure & Macdonald, Lith. London.

Trans. Linn. Soc. 2 Ser. Bot. Tab 8.

PARADIGMA GALLEOTTIANA.

PLETHOSTEPHIA ANGIOCARPA

J. Miers, del.
M'Clure & Macdonald, Lith. London

THE

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M.DCCC.LXXV.

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III. *On the Origin of the prevailing Systems of Phyllotaxis. By the Rev.* George Henslow, *M.A., F.L.S., F.G.S.*

(Plate IX.)

Read February 4th, 1875.

INTRODUCTION.—In my paper "On the Variations of the angular divergences of the Leaves of *Helianthus tuberosus*" (Trans. of the Linn. Soc. vol. xxvi. p. 647), the concluding paragraph commenced as follows:—"If we limit our inquiries to the conditions of the primary [ordinary fractional] series alone, we find, as a fact in nature, that if we assume any leaf as No. 1, then No. 2 lies at an angular distance from it, between 120° and 180° inclusively. If we ask why it is so, no answer can be given. Further, starting with this condition, we find the second leaf has an inherent tendency to take up a definite point as its position along that arc. . . . . . If we ask why it is so, or why the second leaves are not *anywhere* upon that arc, there is as yet no answer to this question any more than to the first."

In the present paper I propose endeavouring to reply to both these questions, and to expound what appears to me to be the fundamental origin of the various systems of phyllotaxis exemplified in nature.

The Spiral arrangement is deduced from Opposite and Decussate Leaves.—If a stem (as of the Jerusalem Artichoke) be found having opposite and decussate leaves from the base upwards, but becoming converted into an alternate and spiral arrangement above (a not uncommon feature), the first process of such a change is the development of short internodes, so as to separate the leaves of each opposite pair, as in fig. 1. The numbers represent the leaves, which are supposed to occupy their original decussating positions. *The order of the numbers* shows the true spiral arrangement now produced by this development of new internodes, and which are indicated by the thin lines, while the original and long internodes are represented by the thicker portions of the spiral.

In other words, if a line be drawn from leaf to leaf successively, it will be spiral, and will pass through the leaves in the order indicated by the numbers on the projected helix (fig. 1). (*See note*, p. 45.)

In following up this spiral line, it will be seen that just those numbers which are the denominators of the fractions of the usual (primary) series, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, fall over one another, viz. 0, 5, 8, 13, 16 [$=2\times 8$], and 21. Similarly the number of coils of the helix between 0 and each of these numbers successively supplies the numerators. Thus there are *two* coils between 0 and 5; *three* coils between 0 and 8; *five* coils between 0 and 13; and lastly, *eight* coils between 0 and 21.

The denominators of the first two fractions (2 and 3) are not represented amongst these numbers; the reason for this will be explained further on.

In the diagram the leaves are represented as retaining their originally decussating positions; but practically, while the internodes are being developed, the leaves *shift their positions*, as it were, and obey the following law:—

The angular distance between any two successive leaves, when projected on the same horizontal plane, is constant.—The rationale of this law seems inexplicable, because we cannot say what causes a leaf to grow out of the axis of a bud at one particular point rather than another. All that can perhaps be suggested is, that as an equable distribution of light may be thus presumably acquired by every leaf, so natural selection may have been a determining influence; but there would seem to be no grounds for assuming external influences to have been the *sole* originating causes *. Whatever be the ultimate facts which cause the position of leaves to be what it is, they cannot in the present state of our knowledge be determined †.

This law is found to be true both for normally alternate leaves and for those which have arisen on a stem by the development of internodes, on which the lower leaves were opposite or whorled in threes. The following observations are the author's, and quoted from the paper alluded to above (p. 654):—

"A change from verticils of threes into $\frac{2}{7}$ was frequent. It takes place in the following manner:—The first step is to cause the three leaves of the different whorls to separate slightly by a development of their internodes. Then, if any two consecutive whorls be examined, the order of succession of the six leaves (No. 1 being the lowest leaf) is thus,—

6

3 2

7 9

8

4 5

1

in which it will be noticed that the 4th leaf, instead of being over the interval between the 1st and 2nd, is over that between the 1st and 3rd; so that the angle between the

* The 'Text-Book of Botany,' by Sachs (translated by A. W. Bennett), p. 179, may be here consulted.

† Mr. Hubert Airy has started the proposition that "leaf-arrangement exists for and is determined in the bud." And his "condensation theory" of leaf-arrangement depends upon "the contact among the balls which [he] uses to represent embryo leaves." ('Nature,' vol. vii. p. 442.)

I venture to call in question both of these fundamental conditions of his theory.

That plants generate their buds during a short summer in readiness for the first sufficiently warm weather in spring is an obvious fact; but that they should be obliged to keep the buds so long undeveloped is no fault of theirs, but a circumstance dependent upon climate. When once a bud is made, and the only opportunity is the comparatively short time the plant is in leaf, it matters not whether it remain a week, a month, or six months. The duration can have nothing to do with the formation of it, or of the importance of any peculiar leaf-arrangement.

If, however, we substitute *vernation* for leaf-arrangement (as synonymous with phyllotaxis), it will be perfectly true: for the half-formed leaves are folded in various ways, so as to to render the bud as compact as possible. Moreover there is nothing in the structure of buds to justify the comparison of embryo leaves to balls. They are not balls at all, but, rather, conical with more or less *flat surfaces*. Although the apex of a leaf may first appear as a hemisphere, it does not retain that form, but elongates into a cone by the time the next leaf emerges from the axis;

1st and 2nd leaves, or between the 2nd and 3rd, is *double* that between the 3rd and 4th. These latter, it will be remembered, are separated by a long internode. The same order obtains with the succeeding whorls; the nodes, however, are now much more widely separated, while a true spiral arrangement, with the same and constant angular distance between all its leaves, is ultimately secured, and is henceforth continued uninterruptedly into the terminal bud, and represented by the fraction $\frac{2}{7}$."

An exactly analogous process takes place with opposite leaves in passing, for example, into the $\frac{2}{5}$ arrangement. Internodes are, of course, developed; and the leaves of the first few pairs that are separated from each other have not, if projected, an equal or correct angular distance of 144° between them successively; but just as in the production of the $\frac{2}{7}$ spiral arrangement from whorls of threes, so is it here—that as the $\frac{2}{5}$ plan is continued up into the terminal bud, the leaves "right" themselves, as it were, and then ultimately come to obey this law accurately by securing a constant angular divergence. Fig. 140, on p. 168 of Sachs's 'Hand-book' mentioned above, illustrates this fact, though that author has not detected the significance in the order of development of the leaves.

The origin of Cycles.—It will be gathered from the foregoing remarks and from fig. 1 that *a cycle is formed from a definite number of pairs of decussating leaves.* Thus, if opposite leaves give rise to the $\frac{2}{5}$ arrangement, then the three pairs (0, 1) (2, 3) (4, 5) are required to produce the first cycle. Having once, as it were, "started" it, the subsequent leaves are developed in accordance with the above law, the angular divergence between every two consecutive leaves being 144°. Similarly, if opposite leaves pass into the $\frac{3}{8}$ arrangement, then, in addition to the first three pairs, two others (6, 7) (8, 9) are required; so that if the first cycle embracing leaves 0 to 7, inclusive, be secured, the subsequent leaves are developed according to the same law, requiring, however, 135° as their constant angular divergence.

Hence it appears that while some plants have taken *three* pairs of the originally decussating leaves to form a cycle, *i. e.* of the $\frac{2}{5}$ arrangement, other plants have required *five* pairs, others *seven*, while cones frequently demand *eleven* pairs; so that the 21st leaf, or the first of the second cycle, falls over that of the first cycle, or that indicated in the figure as 0.

Here, again, it does not seem possible to say why one plant, or even part of a branch, should thus convert a definite number of pairs of opposite and decussate leaves into a cycle of some alternate arrangement. We can conceive of nature distributing the leaves of all plants in which they are alternate simply and solely in accordance with the law given above, while it might have remained indifferent as to the precise amount of the angular divergence. As a matter of fact, however, this angle is determined by the

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and the fact that *the point of emergence* is determined, so to say, from *within* the axis before the leaf is formed seems fatal to the condensation theory.

Again, Mr. Airy takes no account of stipules, which according to his theory ought to interfere materially in leaf-arrangement, because, if not petiolar (as in Rosaceæ) they rise from the axis exactly like leaves, and may even, as in the Elm and Lime, grow to as much as four times the size of the leaf to which they belong. Hence with, say, two minute leaf-apices and four subglobular or, what would be more true to nature, conical stipules, we may ask, What becomes of the "contact theory" when the subsequent development proves that the leaf-arrangement has not been interfered with?

number of leaves constituting a cycle, which cycle has itself been determined by the number of pairs of leaves of the originally decussate arrangement.

It may be again observed that when numbers of the "secondary" series, viz. $\frac{1}{3}$, $\frac{1}{4}$, $\frac{2}{7}$, $\frac{3}{11}$, &c., occur, as in the Jerusalem Artichoke, they do so from an analogous process arising out of whorls of threes. Further, in tracing the phyllotaxis of plants of palæozoic ages, it appears that, besides representatives of the usual or primary and secondary series, some instances occur (as in species of *Lepidodendron*) which have resulted from the breaking-up of whorls of fours, giving rise to the tertiary series $\frac{1}{4}$, $\frac{1}{5}$, $\frac{2}{9}$, &c.; while even a quaternary series, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{2}{11}$, &c., finds a representative in *Knorria taxina*, the phyllotaxis of which is said to be $\frac{5}{28}$ *. At the present day, however, any other than the primary series is comparatively rare.

Correlation between Internodes and Angular Divergences.—If a stem grow rapidly, or at least develop internodes of considerable length (as is the case with the Jerusalem Artichoke), the fraction representing the subsequent arrangement of the leaves upon it will be a "low" one of the series. If, however, the internodes be very short, then, conversely, the leaves or their equivalents will be represented by one of the higher fractions, such as $\frac{5}{13}$, $\frac{8}{21}$, $\frac{21}{34}$, &c., as is well seen in cones, involucres, &c. There appears at present to be no better explanation of this correlation than the one already alluded to, namely the object of avoiding interference of one another. This, however, the author is inclined to regard as a distinct factor in the causes which regulate leaf-arrangement. It will be easily seen that if leaves are on the $\frac{2}{5}$ plan, with very short internodes, the 6th leaf *will lie immediately upon the surface of the first*, what would be called "opposite" in flowers, especially if the leaves be sessile; but if they be on the $\frac{5}{13}$ or, better still, $\frac{8}{21}$, then the 14th or 22nd leaf will be freer from the first, as seen in the scales of a cone.

The Divergence $\frac{8}{21}$ determines all higher ones of the primary series.—In fig. 1 it will be seen that the following numbers occur in the same vertieal line,—0, 5, 8, 13, 16 [$=2\times 8$], and 21. Or, if written thus, 0, 5, $5+3$, $8+5$, $13+3$, $16+5$, &c., the numbers can easily be ascertained to any height required. If this be done, it will be discovered that the numbers 34, 55, 89, 144, which form the denominators of the fractions higher than $\frac{8}{21}$, do not fall in this same vertical line; and the question might be asked, on the supposition advanced in this paper, how it ever happens that higher fractions than $\frac{8}{21}$ are represented in nature. The reply is, that while the numbers 5, 8, 13, and 21 give rise to the divergences $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, and $\frac{8}{21}$ respectively, yet this last, $\frac{8}{21}$, *supplies all the higher fractions.* That is to say, if the spiral arrangement represented by $\frac{8}{21}$ be projected as a helix, and the numbers noted down, to (say) the 90th leaf, then the 34th, 55th, and 89th leaf *will be found lying nearest to the vertical line,* alternately right and left of it, while each of these leaves approximates nearer and nearer to it respectively, as will be seen by referring to fig. 2. Moreover, as the initial leaves of successive cycles of arrangement represented by the fractions $\frac{8}{21}$ and higher ones, cannot be in a truly vertical line, it becomes often difficult to fix upon the leaf most nearly vertical; in fact it is almost, if not quite, arbitrary whether we select the 34th, 55th, or 89th leaf. We may go further, and say that the discovery or proof of a gene-

* Alluded to in Prof. Balfour's 'Palæontological Botany.'

rating spiral for any higher than $\frac{3}{8}$ is impossible; or perhaps it would be better to say that, for any other arrangement than those represented by the fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, and $\frac{3}{8}$, the phyllotaxis is more or less uncertain, and the idea of a definite or *exact* generating spiral becomes more or less evanescent. In the latter case the reason for hesitating to pronounce which is most nearly vertical over the first selected, arises from the fact that neither the axis nor the leaves or scales are ever developed with mathematical accuracy, notwithstanding the fact that the position of the leaves may be mathematically projected.

It will, then, be seen how all apparently higher arrangements than $\frac{8}{21}$ are due to *that* divergence itself; for this is the highest that can be determined from opposite leaves *.

Moreover, to say that the angular divergence represented by $\frac{8}{21}$ furnishes all the higher ones, is, to some extent, if not inexact, yet a somewhat incomplete statement; for in certain cases $\frac{5}{13}$ has the same effect, since this fraction is also irrational to the circumference. Thus in some cones of the Scotch Fir, while the 13th scale is very nearly over the first, even the 34th leaf may not be far from the same vertical line, and so render it doubtful as to which fraction may best represent the phyllotaxis. However, it must be remembered that no higher denominator than 21 can be secured from opposite leaves, as stated above and shown by fig. 1.

The reason why $\frac{8}{21}$ is the most usual kind of phyllotaxis with closely compacted scales seems due to the fact that *it forms the nearest approximation to the alternation of whorled leaves,* only *one row* of scales lying between those containing Nos. 0 and 21 respectively.

Theoretical considerations.—Of course it is here only advanced as a theory that nearly *all* spiral arrangements of Dicotyledons, at least, have been originally derived from opposite leaves; for although they have such in the cotyledons of their embryos, yet the very first leaves of the plumules (as is well seen in a germinating acorn) at once assume their own peculiar spiral arrangement. Yet at the same time it must be remembered that the theory is founded upon the fact that when a branch has opposite leaves below and alternate above, the latter *are* developed according to the law expressed in fig. 1.

The law of embryology, that a member of a higher grade passes in its *embryonic* state through the conditions of a lower grade when in its *adult* state, would seem to hint at this being at least probable, and that opposite leaves were probably the original and normal state of the primogenitors of dicotyledonous angiosperms.

Moreover, when we remember that whorled leaves were apparently very frequent in the carboniferous epoch, and that instances of symmetrical reduction are common amongst plants, *e. g.* in the floral whorls of *Circæa* as compared with *Epilobium* (in which

* It may be said on *à priori* grounds that the failure of the theory in deducing any higher fractions than $\frac{8}{21}$ from opposite leaves is unfavourable to its acceptance; but it must be remembered that no theory is to be tested by what may be imagined it should account for, but by what it *does.* Now this theory, the author maintains, does account for all that is necessary; and any assertion that $\frac{13}{34}$ and higher fractions *ought* to arise *directly* out of opposite leaves is a merely subjective impression not necessarily requiring to be correlated with any objective fact. If they can be satisfactorily accounted for, as the author maintains they can, as stated, from the $\frac{8}{21}$ arrangement, then all that is required has been done.

latter genus, it may be observed in passing, there is a frequent change from opposite to alternate leaves), that the numbers 'fours,' 'fives,' and 'sixes' are often found amongst the whorls of the flowers on the same Jessamine, Elder, Rue, &c., and, again, that there is the positive fact of opposite and whorled leaves passing into spiral on the same stem, as in *Epilobium*, there would thus seem to be a just inference that the great majority of instances of spiral phyllotaxis have taken their origin from whorled and opposite arrangements.

Opposite Leaves generally fail to produce the $\frac{1}{2}$ and $\frac{1}{3}$ arrangements.—On referring to the figures of the diagram (fig. 1), it will be seen that for decussate leaves to become spiral and *distichous* (that is, to be represented by the fraction $\frac{1}{2}$) the third leaf, No. 2, must, as it were, pass through 90° in order that it may fall over the first (or 0). Similarly if decussate leaves were to pass into the spiral arrangement represented by $\frac{1}{3}$, *i. e.* to become *tristichous*, the fourth leaf, No. 3, must fall over the first. In all other cases the leaves have to shift through a much less angle than 90°. This may be the reason why $\frac{1}{2}$ and $\frac{1}{3}$ are by no means common amongst Dicotyledons. On the other hand, they appear *particularly* frequent amongst Monocotyledons. The above failure in producing the $\frac{1}{2}$ and $\frac{1}{3}$ arrangements is on the supposition that the spirals result from the conversion of a definite number of *pairs* of opposite leaves. On referring, however, to fig. 1, it will be seen that if leaf (0) be neglected, and No. 1 represent the first leaf, then the 4th is actually over the 1st, and thus will give rise to the $\frac{1}{3}$ plan. This may have been the origin of the tristichous arrangement amongst Dicotyledons, as well as of the ternary symmetry which occasionally occurs in the flowers of that class; but it is comparatively rare in both leaves and flowers; and this seems to correspond with the fact that it is usual to convert *complete pairs* into alternate leaves. As an additional fact it may be mentioned that other rare arrangements, such as $\frac{4}{11}$, $\frac{7}{11}$, $\frac{11}{29}$, &c., which occasionally occur in nature, can be deduced from it, and lend proportional aid to the acceptance of the theory. This will be better seen by referring to the scheme appended to this paper (fig. 3).

Before suggesting a cause for this latter fact, it would be as well to state that, in every case that I have examined, wherever leaves have to be represented by $\frac{1}{2}$ in Dicotyledons, I believe it is an effect produced by habit of growth resulting in an apparent production of the $\frac{1}{2}$ or $\frac{1}{3}$ arrangement. Thus, if the leaves on a shoot of Ivy growing against a wall be compared with those on a free (barren) branch, or the leaves of the common Yew with those of the "fastigiate" variety—or, again, comparing the leaves on a horizontal bough of the common or Portugal Laurel with those on a shoot growing freely upwards, it will be seen at once how the usual and really or apparently distichous arrangement reverts to the manner of growth represented by $\frac{2}{5}$ or $\frac{3}{8}$, thereby revealing the fact that in those (and probably all other) instances the leaves were not originally distichous, but have only acquired that arrangement by habit.

I have, indeed, reason to suspect that it is only in those instances where the leaves of a branch lie in one and the same horizontal plane, from a peculiar habit of growth, that the $\frac{1}{2}$ and perhaps $\frac{1}{3}$ arrangement occurs, and that this obtains mostly in a certain number of instances, where the leaves are broad and not dissected; for deeply gashed or com-

pound leaves, as in the May and Ash, permit the ingress of light and air, so that a "higher" spiral divergence is permissible, in that the leaves need not all be brought to the surface of the tree.

As other examples of these divergences, may be mentioned the Alder, Lime, and Elm, the first of these being usually regarded as having its leaves arranged on the $\frac{1}{3}$ plan. This may also be due to peculiarity of growth, especially as the scales of both male and female catkins (of the Alder) are on the $\frac{2}{5}$ plan.

Again, if it be noticed how the Lime and Elm spread out their leaves on horizontal planes, just as in the case of the garden-Laurel, the influence of light &c. already alluded to can be supposed to some extent able to have induced this arrangement; how far, however, it is impossible to say; for although light will cause fully developed leaves to turn to it, we do not know if it can cause a leaf to grow out at a particular point on the axis of the bud, so as to secure a more favourable position as regards the light, in *anticipation*, as it were, of its adult state. It is obvious that, of such broad leaves as these trees possess, if they were grouped spirally round the branch, some would fall underneath in the shade of the others, whereas by being, as they are, on the same horizontal plane, they all become equally favoured.

Hence has arisen, as I believe, these distichous and, so to say, pseudo-distichous * and tristichous arrangements, which are by no means common amongst Dicotyledons †.

Having now seen that, whenever *distichous* and *tristichous* leaves are found amongst Dicotyledons, they may most probably be regarded as *not* issuing directly from opposite leaves, it may be observed, on the other hand, that these arrangements are particularly characteristic of Monocotyledons, as in *Iris*, orchids, grasses, &c. To ascertain a cause for this, let us again go to the embryo. Here we have but a single cotyledon. Now it must be observed that, for any arrangement of the usual or primary series, no portion of a spiral which when projected constitutes a circle ever contains more than three leaves; or, with the exception of the distichous, such a circle *always does* contain three leaves. It will be at once seen that the distichous and tristichous, or the $\frac{1}{2}$ and $\frac{1}{3}$ plans, are the only kinds which admit of *one complete cycle* being projected in a circle. In the former the leaves are at opposite extremities of a diameter, in the latter at an angular distance of 120°. Hence there are these two methods of equalizing the distance between the leaves, and at the same time securing a cycle and satisfying the laws already stated.

Thus, then, we may perhaps be able to account for the fact that $\frac{1}{2}$ and $\frac{1}{3}$ do frequently represent the leaf-arrangements amongst Monocotyledons. On the other hand, the conspicuous absence of arrangements represented by $\frac{2}{5}$ and higher fractions is a significant fact affording negative evidence of great value.

* I make the distinction between *distichous* and *pseudo*-distichous, to indicate the fact that in some cases, as in the Yew and *Taxodium*, the leaves are only apparently distichous in consequence of a twist in the petioles—a result more easily conceivable to be due to light than the truly distichous arrangement, as in the Laurel and Beech, in both of which the leaves or vertical shoots often revert to higher spiral arrangements.

† I take this opportunity of remarking that while examining the buds of these trees, I think I have discovered the cause of their unsymmetrical development—namely, that it is due to the position of the stipules, which lie obliquely across the two edges of the folded (conduplicate) leaf, thereby allowing one margin to develop more freely than the other. The bud-scales in both Elm and Lime are stipules.

The relative Ages of the classes Dicotyledons and Monocotyledons.—If any thing as to the relative ages of these classes can be argued from the foregoing facts, it would seem that Monocotyledons are of greater antiquity than at least angiospermous Dicotyledons, in that they furnish differentiated stages of leaf-arrangement issuing from an arrested condition of the embryo—that is, on the assumption of whorled leaves having preceded opposite, and opposite alternate, and that the single cotyledon of a monocotyledonous embryo has resulted from the arrest of another *. The fragmentary character of many monocotyledonous groups, as witnessed by a greater proportion of isolated orders and genera † than in angiospermous Dicotyledons, as well as the very general prevalence of albumen (excepting water-plants), *i. e.* a retention of an embryonic character, may be brought forward as reminders that other facts corroborate this idea; while, as far as the scanty evidence of geology can take us, Monocotyledons seem to have been represented in the primary epoch (though some palæontologists contest this), yet no instance of an angiospermous Dicotyledon has yet been forthcoming from the same period.

Explanation of the Scheme (*fig.* 3).—In this scheme are represented the relative positions of the leaves of the ordinary phyllotaxis. The figures connected by double lines are those which give rise to the fractions

$$\tfrac{2}{5}, \tfrac{3}{8}, \tfrac{5}{13}, \tfrac{6}{16} \left[= \tfrac{3}{8}\right], \tfrac{8}{21}, \tfrac{13}{14}.$$

* In suggesting this process of reduction from whorled leaves as the origin of opposite in Dicotyledonous embryos, and of a single cotyledon in Monocotyledons, I may seem to differ somewhat from Mr. Herbert Spencer's views expressed in his 'Principles of Biology,' vol. ii. p. 67, where he conceives of both Dicotyledons and Monocotyledons as diverging from a common ancestral type, the former having the first two folial or thalline organs flattened out in virtue of the requirement of strength by a development of the midrib, which therefore does not necessitate their being rolled into the form of a cylinder to acquire strength, as in Monocotyledons; and, secondly, to use his own words, "if we assume, as the truths of embryology entitle us to do, an increasing tendency towards anticipation in the development of subsequent fronds—if we assume that here, as in other cases, structures which were originally produced in succession will, if the nutrition allows and no mechanical dependence hinders, come to be produced simultaneously, there is nothing to prevent [a passage from an alternate to an opposite condition in the development of the first two thalline or folial expansions]."

If this "assumption" simply means "arrest" of the internode of the second frond, he is probably right, as it appears obvious that an alternation is acquired solely by the development of an internode. But the process of such internodal development appears rather to be due to the presence of extra nourishment and rapid growth, than the reverse, as seems to be implied by Mr. Spencer; for his words intimate that nutrition must determine the opposition rather than the alternation. But I cannot help thinking that neither nutrition nor the want of it is the *vera causa*. They may determine more or less the *growth* but not the *development*. It is to me inconceivable how mere physical causes could have produced, for example, the fundamental distinction between an exorhizal dicotyledonous axial root and the endorhizal character of monocotyledonous adventitious roots—a feature which Mr. Spencer does not appear to have considered, and which is really due to the arrest of the primary or axial root in the latter, and which is therefore correlated with an arrested cotyledon; and, it may be added, an arrested condition is the presence of unconsumed endosperm, so general in all terrestrial Monocotyledons.

Hence I conclude that an alternate or spiral arrangement in Dicotyledons results from the *development* of internodes, but in Monocotyledons in consequence of the *arrest* of one cotyledon.

† I find from a calculation of the orders and genera given in Le Maout and Decaisne's 'Descriptive and Analytical Botany,' edited by Dr. Hooker, that of Monocotyledons about 60 per cent. of the orders comprising that subkingdom have less than 6 genera, and nearly 33 per cent. have less than 3 genera; whereas of Monochlamydeous exogens, omitting Gymnosperms, there are about 40 per cent. of orders with less than 6 genera, and 26 per cent. with less than 3. Lastly, of Dichlamydeous exogens, there are no more than 28 per cent. of orders with less than 6 genera and about 15 per cent. with less than 3.

No. 34 is placed vertically over 0. Strictly, however, this should be slightly to the left of the vertical line (but it would be inconvenient to allow for deviations due to minutes and seconds); for since 34 is not rational to the circumference, or a measure of 360, that leaf could never fall absolutely vertically over the first (0).

The scheme may therefore be considered as approximately representing the $\frac{13}{34}$ plan.

The figures connected by single zigzag lines are those which give rise to the series

$$\tfrac{1}{3},\ \tfrac{3}{8},\ \tfrac{4}{11},\ \tfrac{6}{16}\ [=\tfrac{3}{8}],\ \tfrac{7}{19},\ \tfrac{9}{24}\ [=\tfrac{3}{8}],\ \tfrac{10}{27},\ \tfrac{12}{32}\ [=\tfrac{3}{8}],\ \tfrac{13}{35},\ \text{\&c.}$$

and which, as has been shown, are deducible from opposite leaves by omitting the lowest or first.

There are several other fractions which represent the angular divergences of leaves occasionally met with in nature, but which have hitherto not been referred to any phyllotaxis.

Thus Hofmeister, in his 'Handbuch der physiologischen Botanik,' mentions the following:—

$$\tfrac{3}{7},\ \tfrac{4}{11},\ \tfrac{7}{11}\ (\tfrac{7}{18}),\ \tfrac{7}{20},\ \tfrac{11}{31},\ \tfrac{14}{31},\ \tfrac{18}{47}\,*.$$

He endeavours to show how these *may* be derived from fractions of the ordinary series by a slight decrease or increase of the angular divergence, thus:—

$$\begin{aligned}
\tfrac{3}{7} &= \tfrac{2}{5} + \tfrac{1}{35} \text{ or } = \tfrac{1}{2} - \tfrac{1}{44}\\
\tfrac{4}{11} &= \tfrac{3}{8} - \tfrac{1}{88} \text{ or } = \tfrac{1}{3} + \tfrac{1}{33}\\
\tfrac{7}{11} &= \tfrac{5}{13} + \tfrac{1}{234} \text{ or } = \tfrac{2}{5} - \tfrac{1}{90}\\
\tfrac{7}{20} &= \tfrac{2}{5} - \tfrac{1}{20} \text{ or } = \tfrac{1}{3} + \tfrac{1}{60}\\
\tfrac{11}{31} &= \tfrac{2}{5} - \tfrac{7}{155} \text{ or } = \tfrac{1}{3} + \tfrac{2}{93}\\
\tfrac{14}{31}\dagger &= \tfrac{1}{3} + \tfrac{2}{93} \text{ or } = \tfrac{1}{2} - \tfrac{3}{62}\\
\tfrac{18}{47} &= \tfrac{13}{34} - \tfrac{1}{1598} \text{ or } = \tfrac{5}{13} + \tfrac{1}{611}.
\end{aligned}$$

To these may be added $\frac{7}{19}$ and $\frac{11}{29}$.

Now, of these, $\frac{4}{11}$, $\frac{7}{19}$, $\frac{7}{20}$, $\frac{11}{29}$, and $\frac{11}{31}$ can be more easily obtained from the new series, commencing $\frac{1}{3}$, $\frac{4}{11}$, &c., as given above.

For $\frac{4}{11}$ and $\frac{7}{19}$ result immediately from opposite leaves when the lowest leaf is neglected. Now $\frac{7}{20} = \frac{4}{11} - \frac{3}{220}$, and therefore differs from $\frac{4}{11}$ by a much smaller fraction than from $\frac{2}{5}$ or $\frac{1}{3}$. Again $\frac{11}{31}$ differs from $\frac{4}{11}$ by only $\frac{3}{341}$.

So that while of the above anomalous fractions $\frac{3}{7}$, $\frac{7}{11}$ (which is simply the *reverse* of $\frac{7}{18}$), and $\frac{18}{47}$ are deducible from some number or other respectively of the usual series, $\frac{4}{11}$, $\frac{7}{20}$, $\frac{11}{31}$, and also $\frac{7}{19}$ and $\frac{11}{29}$, are to be obtained by starting with $\frac{4}{11}$, which, in turn, is directly obtainable from opposite leaves ‡.

* Excepting $\frac{14}{31}$, these are indicated on the scheme by means of arrows.

† This fraction $\frac{14}{31}$ I cannot account for, unless it approximates the *reverse* of some other; otherwise it cannot belong to the usual series, as there must be always 3 leaves in every projected circle of a cycle; consequently 14 appears to be too high a number (of cycles) for 31 leaves.

‡ Since this paper was in type I have met with a curious exception in *Lagerströmia*, in which the order of the leaves, instead of forming a spiral, "oscillate" through three quarters of a circle. The first four leaves succeeding the opposite are as in fig. 1; but the subsequent arrangement is as follows—0, 1, 2, 3, 5, 4, 7, 6, 8, 9, 10, 11, 13, 12, 15, 14, 16, 17, 18, 19, 21, 20. This, perhaps, may prove to be the clue to the origin of distichous leaves amongst Dicotyledons.

Fig. 1.

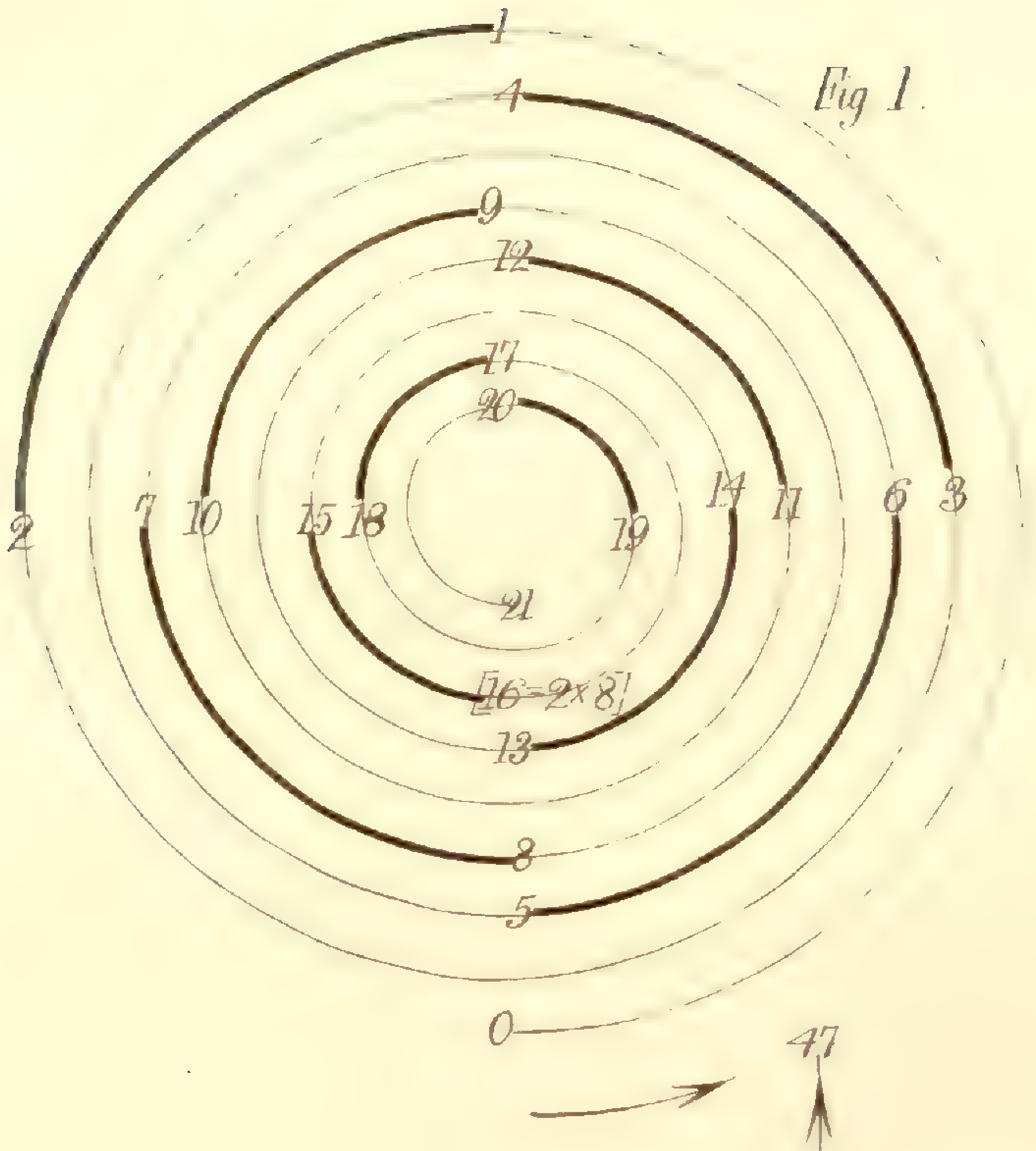

Fig. 2.

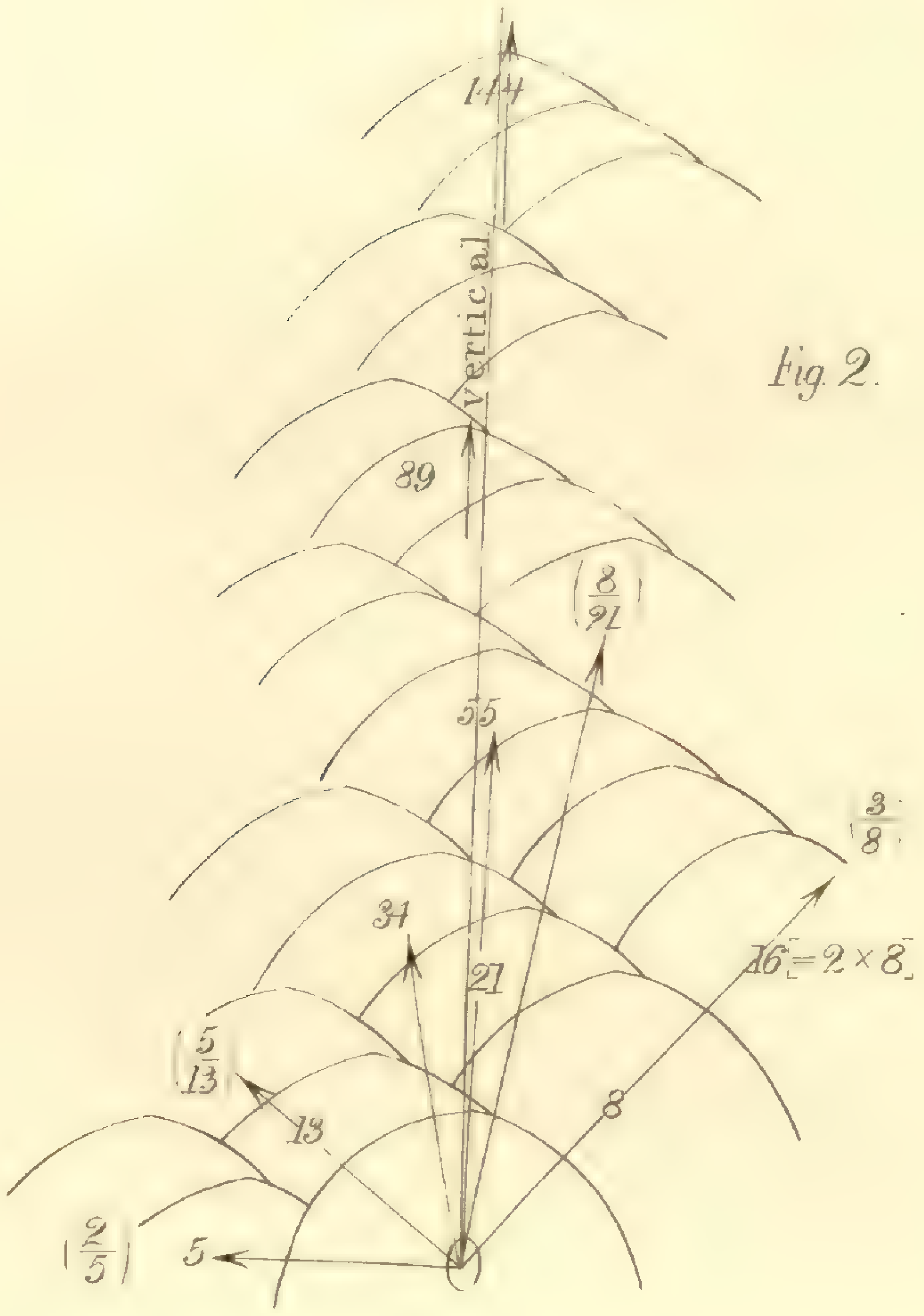

Fig. 3.

G. Henslow del.

G. Jarman sc.

IV. *On the* Barringtoniaceæ. *By* John Miers, *F.R.S., F.L.S., Dignit. et Commend. Ord. Imp. Bras. Rosæ, &c.*

(Plates X.–XVIII.)

Read June 3rd, 1875.

THE *Barringtoniaceæ* form an extremely natural group, offering very distinct and uniform characters; they differ from the *Myrtaceæ* in their alternate leaves without pellucid dots, in another kind of inflorescence, and in a fruit of very different structure. The *inflorescence* is either terminal and thyrsoid, with several approximated flowers, often of extraordinary dimensions, fixed upon a thick erect terminal stem, or more generally consisting of smaller flowers, spicately arranged upon long terminal pendulous racemes, sometimes subaxillary, or more rarely in branching panicles; but in all cases the flowers are formed upon one uniform plan.

The leading character of this floral structure is, that their very numerous long slender stamens, in many series, are united at their base into a shortish erect monadelphous tube, seated on the outer margin of a horizontal annular epigynous disk, from which they all fall off together, thus differing essentially from the *Myrtaceæ*, where the similar stamens are always free, each seated independently upon a perigynous annular disk, from which they fall off separately, leaving upon it many cicatrices, marking the several points of their previous attachment upon it. There is little analogy in this respect with the structure of the *Lecythidaceæ*, where the short small stamens are separately supported upon numerous distinct processes, attached to a large petaloid organ (androphorum), of which no parallel is to be found in any other natural order.

Another peculiarity of the *Barringtoniaceæ* is, that the *tube* of the *calyx*, agglutinated to an inferior ovary, is expanded above into a free *limb*, which in many cases offers the very singular feature of being vesicoid, quite entire and undivided in the bud, marked by many parallel nerves, all meeting in a mucronate point in the apex; after a while, by uniform internal pressure, caused by the growth of the petals and stamens, this limb becomes ruptured along the nervures, splitting into 2, 3, or 4 subequal segments, which eventually, little changed, are persistent, and crown the summit of the fruit. In other genera of the family the limb of the calyx consists of 4 free, small, rounded sepals, slightly imbricated in æstivation; in a single instance it is cup-shaped, with an almost entire margin.

The *petals*, constantly 4 in number, are generally 3 or 4 times as long as the calycine limb, are oblong, rounded, narrowing towards their base into fleshy claws, which are agglutinated to the monadelphous tube of the stamens so firmly that all fall off together.

The *stamens* in several series are closely united at their base into a monadelphous tube; the *filaments* are slender, somewhat longer than the petals, and are spirally coiled in æstivation, but afterwards they spread into a feathery plume, are mostly furnished, at their curving apex, each with a small 2-celled *anther*; but in some genera those of the outer or of the inner series are bare, the intermediate series alone bearing anthers.

The *style*, which rises from the centre of the ovary, is generally longer than the stamens, is subulate, rather slender, slightly curved, and terminated by a small clavate or lobed *stigma*, and is always persistent on the fruit.

Another feature of importance is the *disk*, which assumes a form so peculiar that it enables us to determine whether any plant presented to our notice belongs to *Barringtoniaceæ* or not—a test of much practical value. As before stated, it is epigynous, flat and annular, and bears upon its outer margin the staminiferous tube, while its inner margin is always more or less expanded into an erect urceolate prominence, sometimes into a tube of some length, which encircles the base of the style, leaving within it a deep hollow over the vertex of the ovary.

The *ovary* also affords good distinctive characters among some of the genera; it is always inferior, and adnate to the tube of the calyx; it is either 2- or 4-celled, with one or two, sometimes more, ovules in each cell. These *ovules* in some cases are erect, but more frequently are suspended from the summit of the cells by distinct funicles; or, when more numerous, they are attached to the axis; in all cases they are anatropous. In their subsequent development generally most of the cells are abortive, leaving only a single fertile cell; and in that only a solitary ovule is matured.

The *fruit* varies in form, is generally of a large size, crowned by the free persistent limb of the calyx; it has a thick pericarp, frequently very thick, sometimes fleshy, but more often of a dry spongy consistence, lined within by an endocarp, forming an osseous or a coriaceous shell, covered by adhering longitudinal woody fibres. This shell is sometimes 4-celled, but more frequently, by abortion, only 1-celled, with a single large seed; in the genera *Careya* and *Planchonia* the seeds are smaller, more numerous, and imbedded in a tough pulp. In the African genus *Petersia*, the *fruit* assumes a very unusual form: the indehiscent pericarp is small, linearly oblong, thin, and scabrous outside, and is cruciformly surrounded by 4 rounded membranaceous wings of much larger dimensions: this, by abortion, is 1-celled, containing a few linear terete seeds, attached to a parietal cord formed by its undeveloped three abortive cells. I did not succeed in determining the form or nature of the embryo, owing to the decay of the seeds. In *Barringtonia* and *Planchonia* the fruits are 4-celled, each cell in the latter producing several seeds, imbedded in a tough pulp. In these genera alone the seeds furnish an embryo with two distinct cotyledons, as will be subsequently shown. With the exception of these two and *Petersia*, all the other genera (excluding one) uniformly present in each fruit a single large seed with an embryo of peculiar structure, upon the nature of which the opinions of botanists are much divided; and it is necessary to enter into much preliminary detail to ascertain the value of these conflicting views.

This large *embryo*, apparently homogeneous in texture, invariably consists of two main parts, one concentrically encircled by the other at all points, often so intimately agglu-

tinated together that they appear like one homogeneously solid body; but often, in drying, they become visibly distinct, leaving a narrow vacant space between them. This structure was first demonstrated in 1791 by Gaertner[1], who gave several illustrations of it. He regarded the outer body as albumen, and the inner one as a pseudo-monocotyledonous embryo, consisting of 2 fleshy cotyledons and a radicle, all intimately conferruminated into a solid mass.

Blume, in 1826[2], adopted this view; and DeCandolle, in 1828[3], did the same.

Roxburgh, in 1832[4], accorded with the definition of Gaertner, in considering the nucleus to be formed of albumen, of 2 cotyledons and a radicle, all intimately agglutinated into one solid mass; his description, however, is more important, as he figured and described the changes produced in the act of its germination. Within the pericarp he saw the inner body, which he regarded as the embryo, throw out a long shoot at each extremity, to form a new plant, the rootlet issuing from the summit of the fruit, while a young stem, covered with scales, forced its way through the bottom of the pericarp. He added that "this part, which was a prolongation of the plumular extremity, formed the ligneous centre of the shoots, while the external body furnished the cortical part and the leaves: in this growth there was no appearance of any cotyledon; he saw simply the 2 bodies regarded by him as albumen and embryo." He further explained this development by saying that "the albumen performs the same office as a cotyledon," repeating that "by the elongation of its two extremities it furnishes the bark and foliage of the young plant, while the opposite end of the embryo, or central part, supplies the wood and pith, just as in *Garcinia* and *Xanthochymus*; only there the central portion or embryo is very slender, and the permanent root proceeds from the base of the plumule, as in the Monocotyledones, while that from the opposite end of the embryo soon perishes, or remains slender compared with the other."

Wight and Arnott, in 1834[5], defined this embryo as formed of two concentric homogeneous combined layers, not separable into cotyledons and radicle.

Griffith, in 1835[6], described the seed of *Careya*, and its growth in germination. It consisted of an outer fleshy mass enveloping a central body; the outer body is surmounted by a few fleshy scales concealing others; and these form part of the plumule: as the latter expands upwards, it carries with it the scales, which appear alternating on the ascending stem, which, at its summit, throws out true convolute leaves; at first the scaly plumule is concealed by the lobules on the apex of the external body. It is evident, he says, that the inner subulate body is the root, and the minute scales the plumule; so that the outer fleshy mass ought to be considered cotyledonary in its nature, "and might be explained by supposing the cotyledons to be affixed in a peltate manner, and united into a solid mass." This last passage is very obscure, and assumes what is improbable.

Wight in 1840[7] still inclined to his former opinion, and, in order to explain his views, copied from Roxburgh's drawing the figure of a seed of *Butonica* as it appears when germinating within the pericarp.

[1] De Fructibus, &c. ii. 96, tab. 101. [2] Bijdragen, p. 1096. [3] Prodr. iii. 288. [4] Fl. Ind. iii. 634.
[5] Prodr. Fl. Pen. Ind. p. 333. [6] Proc. Linn. Soc. i. p. 280. [7] Icon. tab. 152.

Lindley, in 1845[1], described the fruit of the *Barringtoniaceæ* as fleshy, and containing many bony seeds lodged in pulp, with an embryo in the axis of copious fleshy albumen.

Wight, in 1850[2], expressed his opinion that in *Careya* the embryo of its seed is placed in the axis of a copious fleshy albumen; and he figured it accordingly.

Blume, in 1852[3], repeated his conviction that in *Butonica* the embryo is exalbuminous, with the cotyledons and radicle intimately combined into one homogeneous fleshy mass, ignoring, as he had done before, that it is composed of two distinct concentric bodies, a fact adverse to his conclusion.

Griffith, in 1854[4], described the embryo of *Butonica* as formed of two conferruminated portions. He imagined that "in its central part the upper end represents a radicle, its lower end a plumule; he also supposed all the parts which he figured, between the lowest scales of the superficies and the radicle, to be an adherent cotyledon, or else an immense radicle, and two or several minute cotyledons represented by scales, and an inconspicuous plumula—a peculiar form of embryo analogous to that of *Dracontium* and, in a less degree, that of *Cryptocoryne*." The presence of these scales, however, was observed only in two species; probably in all the others they were absent. Griffith says distinctly they are absent in his *B. conoidea*. He evidently did not think they formed an essential part of the structure; for in the species he describes he noticed much irregularity in the number and situation of the scales.

Miquel, in 1855[5], merely repeated Blume's definition in his monograph of the family.

Dr. Thomson, in 1857[6], gave an able review of the opinions of botanists on this subject, when he came to the conclusion that this form of embryo is exalbuminous, and consists of 2 concentric layers, that the cotyledons are rudimentary, that in germination the central layer is continuous with the pith, and the outer layer continuous with the bark of the new plant, that the plumule (at least almost without scales) is developed into the new stem, while the opposite extremity is elongated into a root. He adds, that in this development the only appearance of foliary growth is in the series of minute scales upon the ascending axis, as shown in Roxburgh's figure; but these are only rudimentary, for the first true leaves are not developed until that axis is 1 or 2 inches long. He had observed numerous instances of this germination, and adds, somewhat ambiguously, that the new stem is a prolongation of a bud springing from the axil of one of the minute scales observed by Griffith. He shows also the close affinity between this form of embryo and that of the Guttiferæ, as Roxburgh had before pointed out.

Here I am able to offer some new evidence bearing upon this subject. In 1854[7], in my paper "On the Structure of the Seed and peculiar Form of the Embryo in *Clusiaceæ*," I showed that it consisted of 2 layers, one placed concentrically round the other; I gave to the outer one the name of *exorhiza*, and to the inner one that of *neorhiza*, because, in germinating, the latter emitted at one extremity a growing stem, at the other a new rootlet; and in confirmation of this view I copied from Roxburgh's drawing a figure of

[1] Veg. King. p. 754.
[2] Illustr. p. 20, tab. 100.
[3] In Van Houtte, Flor. Serr. iv. p. 72.
[4] Notulæ ad Plant. Asiat. iv. pp. 657, 658, pl. 636.
[5] Flor. Ned. Ind. i. 484.
[6] Proc. Linn. Soc. ii. 52, tab. 1.
[7] Linn. Trans. xxi. 243, tab. 26.

the seed of *Xanthochymus* in germination[1]. I had not then witnessed the fact myself; but not long afterwards Dr. Spruce kindly sent me the seeds of a *Clusia* which he gathered in the act of germination and in its several stages of growth. Here the central body I had described became much broader below, and had forced its way through the apical lobes I had figured, rising in a naked subulate form, till it had grown to 10 times the length of the outer body, which had not enlarged in any way, but which, on the contrary, had withered into a mere membrane, after yielding its substance to nourish the growing portion. No scales were visible on the rising shoot; but when it had reached the height above mentioned, it threw out at its summit at first two, and then other decussating pairs of broad rounded leaflets; and at the bottom of the seed a distinct rootlet was evolved. This agrees perfectly with the figure of Roxburgh; only there were no scales, and no appearance of a second root close to the plumule. The specimens of the *Clusia*-seeds are now before me; so that I can vouch for the correctness of this description.

From this we may gather the important fact that the outer body of the embryo forms here no portion of the new plant, and that its use appears only to perform the part of a cotyledon, in affording nourishment to the inner growing portion. It is probable that the same occurs in the germination of the large fleshy embryo in *Butonica*, which Roxburgh figured as growing in the same manner[2]; but we have no evidence to show what becomes of the outer exorhizal portion in those cases, or that it forms any part of the new plant. This would lead to the conclusion that in *Butonica* the exorhiza is simply a cotyledon under a sheathing form, analogous to the radicle of an ordinary dicotyledonous seed from which the cotyledons have have been cut away, leaving a cylinder consisting of an outer sheath confluent round an inner body, terminated by the plumule. An example somewhat similar is figured by Gaertner in *Hippocastanum*[3], with this distinction, that the plumule is there coleorhized, a very rare circumstance in seeds eminently dicotyledonous.

One important point of structure was noticed by Dr. Thomson in the embryo of *Butonica*: in a section of it, under the microscope, he found that both the exorhiza and neorhiza are alike formed of simple cellular tissue and starch granules, but that between them, adhering to both, there exists a distinct layer of delicate vessels, continuous upwards and downwards with the ligneo-vascular cylinder of the stem and root[4]. This, without doubt, is the medullary sheath described by Mirbel[5], investing the cellular tissue of the axis of the plumular support, and forming there all the vessels which constitute the wood and bark in the new plant.

A very instructive example of the kind of embryo in *Butonica* occurs in that of *Caryocar*, which has a gigantic amygdaloid neorhiza, surrounded by a rather thin exorhiza of uniform thickness; the former is of a crescent form, in the upper horn of which is observed the radicular point, and in the lower horn the plumular extremity. The germination commences within the pericarp, as soon as the seed is formed, by the

[1] Linn. Trans. xxi. tab. 26, fig. 34.
[2] Wight, Icon clii. fig. 5, and Roxb. Flor. Ind. ii. 635.
[3] De Fruct. ii. 135, tab. 111. fig. G, H.
[4] Journ. Proc. Linn. Soc. ii. pp. 51, 52.
[5] Elém. i. 114.

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plumule perforating the thin coating of the exorhiza, and protruding from it in the form of a collet, bearing 2 very small lobes; this is done while it is confined within its entire integument; but the growth is of short duration, being arrested by the strong resistance of the bony nut, while the inward pressure causes the exorhiza to become moulded into the channel in which the plumule lies. The lobes just mentioned were regarded by Gaertner as cotyledons; and so they have been universally considered; but any one who will reflect for a moment must see that they are, in fact, the plumule; for Gaertner says he could discern no other, and his expression "plumula nulla" is an obvious inconsistency.

We may obtain, by means of analogy, some additional light by comparing the embryo of *Butonica* with that of *Rhizophora*, which germinates also within the pericarp. There the ovary is 3-celled, with several ovules; but the fruit, by abortion, is 1-celled and monospermous; the pericarp is oblong, about 1 inch long, coriaceous, partly inferior, mostly superior, terminated by a bifid style, and surrounded above its base by the persistent calyx; the seed which fills its cavity is invested by a thin integument, has no albumen, and an embryo of singular development, consisting of an external exorhiza and an internal neorhiza. The latter, while upon the tree, begins to swell, and forces its way through the integument and through the pericarp, by rupturing a small hole between the lobes of the style, and it grows to a length of 10 inches by the time that the exorhiza has only extended half an inch beyond the pericarp. This exorhiza is 1 line thick, is of a greenish hue, and is filled with soft threads, probably oil-cells, such as I described in the embryo of *Clusia*, its upper extremity being lacerated by the protrusion of the neorhiza, while at its base, within the calyx, it is terminated by a hollow dome of soft yellow consistence, containing no threads; except in this part, it is confluent with the basal portion of the neorhiza, but is free from it at the dome, which encloses the free plumule that terminates the end of the neorhiza and consists of 4 or 6 small leaflets plicated, convoluted, and converging to a point. This dome-shaped portion is called the *calyptra* by Jacquin, the *albumen* by Gaertner[1]; the exorhiza is the *crus* of Jacquin, the *vitellus* of Gaertner; the neorhiza is the *semen* of Jacquin, the *radicula* of Gaertner; while the terminal free end of the neorhiza is the *conus* of Jacquin, and the *cotyledons* of Gaertner. Jacquin gives a long account of its germination and subsequent growth. The semen (neorhiza) becomes the trunk of the new plant; the tubercles on its surface throw out numerous rootlets that form, ultimately, arched buttresses for its support on the sea-bed beneath it; while, at the other extremity, as soon as it can detach itself from the pericarp, the plumule expands into an ascending stem, crowned by permanent real leaves. In this development the exorhiza seems to perform no other part than to afford its nourishing juices to the young plant; and it gradually withers, as in *Clusia*; the medullary sheath coating the neorhiza quickly generates a system of woody vessels, so hard as to render it difficult to be cut by a knife, the neorhiza being contracted into a narrow central pith,—a structure confirmed by the observations of Griffith; the embryo may be said to be coleorhized by the concealment of the plumule within the terminal dome,

[1] Griffith (Notulæ, iv. 664) calls this *cotyledon*.

which bears much analogy to the nipple-shaped process described by me in *Clusia*, apparently divisible into 2 or 4 lobes, which formerly I regarded as rudimentary cotyledons [1].

The kind of solid embryo found in *Butonica* and many other genera, under different modifications, consists, as before said, of an external exorhiza and an internal neorhiza, the latter having a plumule at one extremity and a radicular nipple at the other, the ends expanding in opposite directions in germination, the one being the precursor of the ascending stem, the other of the descending root; between the two main fleshy bodies, and adhering to both, is the medullary sheath [2], consisting of elementary vascular tissue, which, by the nutriment afforded on either side, yields woody fibres to the root, and gives origin to the wood, bark, and leaves of the new plant, the neorhiza, void of vessels, remaining as the central pith, while the exorhiza, also without vessels, merely gives out all its substance as nutriment to the general growth, and, without expansion, gradually dies away, thus performing simply the function of a cotyledon. To avoid frequent repetitions in the following descriptions, this kind of embryo will be said to be *mesopodal*, because the expansion of its growth in germination is always in the axial portion (neorhiza), while the outer portion (exorhiza) finally becomes atrophied.

The name *tigellum* has been given to the analogous kind of embryo in *Xanthochymus* [3] and other Guttiferæ; but it appears to me a very objectionable term, because the word *tigella*, invented by Mirbel in 1815 [4], and since used by all French botanists, denotes that portion of the plumule, in ordinary cases, which lies between it and the neck of the radicle: this, however, is seldom visible till after the commencement of germination. Jussieu also used it in the same sense [5]; but in a previous page he applies it to the great fleshy mass in the embryo of *Pekea* [6]. Consequently the name *tigellum* ought not to be given to an entire embryo of peculiar form when the same designation has been extensively used by botanists to denote a very small portion, and that often invisible, in the ordinary forms of the embryo in the seeds of both exogenous and endogenous plants.

Such are the leading characters of the *Barringtoniaceæ*, from which it will be seen that they differ widely in their structure from the *Myrtaceæ*, and equally so from the *Lecythidaceæ*. With the former they have hardly a single character in common; for the apparent similarity of their numerous long stamens is destroyed by the insertion of each filament separately upon a *perigynous* disk, while in the *Barringtoniaceæ* they stand in many dense series, all united at their base into a monadelphous tube, inserted on the outer margin of a distinctly *epigynous* disk. From the *Lecythidaceæ* they differ in a totally distinct floral structure.

The *Barringtoniaceæ* appear to me to approach nearer to the *Rhizophoraceæ*; indeed, if we imagine in any plant of the former a flower with the staminiferous tube agglutinated to the limb of the calyx, it would at once be referred to the latter family; it would be especially close to the new genus *Harmena*, established by me upon a plant

[1] Linn. Trans. xxi. 246, tab. 26. figs. 8–10, 26, 27.
[2] Mirbel, Elém. i. 110; Juss. Cours Elém. p. 48, fig. 88, 99.
[3] Ann. Sc. Nat. sér. 4, vol. xiv. tab. 17. fig. 15; Trimen, Journ. Bot. 2nd ser. vol. iv. p. 67, tab. 160.
[4] Elém. pp. 50, 601, pl. 57.
[5] Cours Elém. p. 365. fig. 446, p. 366. fig. 447.
[6] *Loc. cit.* p. 350. fig. 420 (in adnot.).

from Fiji, collected by Dr. Seemann, and which, singularly enough, he referred to *Barringtonia speciosa*[1]. In thus alluding to *Rhizophoraceæ,* I mean the order as established by the late Mr. Robert Brown[2], excluding the *Legnotideæ* and *Cassipoureæ*[3], since united with it[4], but which, it seems to me, ought to be located elsewhere, because they differ widely in the habit of the plants, and in their yielding a resinous juice, in the presence of stipules, in a more panicular inflorescence, in their flowers with laciniated or fimbriated petals, in their semi- or wholly superior ovary, in their fruit containing numerous seeds imbedded in pulp, each seed with a terete dicotyledonous embryo enclosed in copious albumen. There seems, indeed, but little intimate relationship between them, while the true *Rhizophoraceæ* form a well-marked family, the uniformity of which is destroyed by its association with the groups before mentioned.

The *Barringtoniaceæ* have no representative in the American continent, their existence being confined to the Old World, over the tropical portions of which they are widely spread, extending from Africa throughout the Indian and Malay peninsulas, growing in the numerous islands of the Malayan archipelago, in Australasia, in the broadly dispersed islands of the Pacific Ocean, but never reaching the continent of the New World, where the *Lecythidaceæ* exclusively occupy their place.

This is a fact of some value in the question of the geographical distribution of plants, and powerfully tends to support the opinion of those who contend for the separate origin of distinct types.

The genera already described by botanists are *Barringtonia, Butonica* (which I have restored), *Stravadium, Careya, Planchonia,* and *Petersia,* to which are now added *Agasta, Doxomma, Megadendron,* and *Chydenanthus,* all marked by peculiar characters, as the following clavis will show:—

GENERUM DISTRIBUTIO.

A. Calycis limbus in alabastro indivisus, maximus, oblongus, demum in lobos 2 ruptus.
  a. Embryo dicotyledoneus: semina plurima . . . . 1. BARRINGTONIA.
  b. Embryo mesopodus: semen solitarium . . . . 2. AGASTA.
B. Calycis limbus in alabastro indivisus, mediocris vel subparvus, demum in lobos 3–4 ruptus. Embryo mesopodus: semen solitarium . . . . 3. BUTONICA.
C. Calycis limbus in alabastro sectus. Sepala 4 imbricata.
  c. Ovarium 2-loculare.
    * Embryo mesopodus: semen solitarium magnum, pericarpium siccum. . 4. STRAVADIUM.
  d. Ovarium 4-loculare.
    ** Embryo dicotyledoneus: semina plurima in pulpa nidulantia . . . . 5. PLANCHONIA.
    *** Embryo mesopodus: semina plurima in pulpa nidulantia . . . . . 6. CAREYA.
    **** Embryo mesopodus: semen solitarium, magnum; pericarpium siccum . 7. DOXOMMA.
    ***** Embryo ignotus: semina plurima, linearia; pericarpium siccum, in alas 4 maximas membranaceas expansum . . . . 8. PETERSIA.
D. Calycis limbus sectus: sepala 3–4, valvata. Embryo mesopodus: semen solitarium, magnum; pericarpium siccum . . . . 9. MEGADENDRON.
E. Calycis limbus integer, cupularis: inflorescentia singulariter paniculata . . . 10. CHYDENANTHUS.

[1] Flor. Viti. i. p. 82. [2] Gen. Remarks, p. 549. [3] For reasons given by Blume (Mus. Bot. Lugd. i. p. 126).
[4] Endl. Gen. p. 1186; Benth. Hook. Gen. Pl. i. p. 678.

1. Barringtonia.

This genus was established by the two Forsters in 1776, after their return from the second voyage of Capt. Cook, when they published very good analyses of its floral and carpological structure [1], the plant itself being well represented in the drawings of Forster and of others who copied the same. The younger Linnæus, in 1781, gave its generic character [2] and details of the typical plant [3], obtained from a communication made to him from Forster; but as the plant and drawings of it were both unknown to him, he wrongly concluded that it was identical with Osbeck's *Mammea asiatica*, with Sonnerat's *Commersona*, and Rumph's *Butonica*.

Blume in 1827 [4], perhaps wholly unacquainted with the details and drawings of Forster, applied the name of *Barringtonia speciosa*, as the younger Linnæus had done, to other plants found by him in Java; hence in his generic character of *Barringtonia* he ascribed to it carpological features quite at variance with Forster's description and analysis; and to this cause we may attribute all the complications that have since occurred.

DeCandolle, in 1827 [5], not perceiving this mistake, adopted Blume's definition unconditionally—an example followed by Roxburgh, Wight, the Dutch botanists, and authors of every nation since that period; and hence the general confusion at present existing, from which I have here attempted to extricate the family.

One of the most remarkable characters of *Barringtonia* is the presence of a dicotyledonous embryo in the seed, a unique occurrence till lately, when the genus *Planchonia* was established by Blume himself [6] upon some plants from the same region, which present an embryo similar to that of *Barringtonia*. There can now, therefore, be no reason for refusing the acceptance of Forster's characters. As yet we know only the typical species; and it is remarkable that no one except Montrouzier appears to have seen the plant since Forster collected it; the only specimen of it extant, as far as I am aware, is the original type, fortunately preserved in the British Museum. Sir Joseph Banks purchased some duplicates of Forster's plants; but no specimen of the fruit appears in the Banksian collection. It is therefore almost wholly from Forster's materials that the following generic character has been framed, a few further particulars being furnished by Montrouzier.

Barringtonia, Forst. (non alior.).

Calyx in parte adnatus, limbo magno, in alabastro oblongo, integre clauso, parallele nervoso, demum in lobos 2 concavos persistentes rupto. *Petala* 4, magna, oblonga, unguibus ad tubum staminigerum agglutinatis. *Stamina* numerosissima, pluriseriata, in tubum cylindricum subbrevem monadelpha, et cum petala conjunctim caduca: *filamenta* subfiliformia, in æstivatione spiraliter convoluta, demum recta, dilatatim expansa, petalis longiora, colorata; *antheræ* subparvæ, dorso basin versus affixæ, ovato-rotundatæ, flavæ, 2-lobæ, lobis adnatis longitudinaliter dehiscentibus. *Discus* epigynus, horizontaliter annularis, pulvinatus, margine externo tubum staminigerum fulciens, margine interno in eminentiam longiusculam anguste tubularem apice dentatam stylum cingentem expanso. *Stylus* subulato-teres, filamenta paullo excedens, persistens. *Stigma* parvum, capitato-oblongum, cavum.

[1] Char. Gen. p. 75, tab. 38. f. *a, b, c*.
[2] Linn. fil. Suppl. p. 50.
[3] Ibidem, p. 312.
[4] Bijdr. p. 1096.
[5] Prodr. iii. 288.
[6] In Van Houtte, Fl. Serr. vii. p. 24.

Ovarium inferum, turbinatum, vertice circa stylum angustissime concavo, 4-loculare; ovula in quoque loculo 3, imo radiatim affixa. *Fructus* magnus, obverse pyriformis, apice sensim attenuatus et calyce coronatus, obsolete 4-gonus, indehiscens: *pericarpium* crassissimum, extus læve; *mesocarpium* crassissimum, subcarnosum; *endocarpium* durum, subosseum, extus fibris rugose lignosis laxe intricatis tectum, intus læve, 4-loculare: *semina* in quoque loculo solitaria, subglobosa, rugosa; *embryo* conformis, exalbuminosus; *radicula* ejus longitudine, teres, incurva, apice sursum spectans, truncata, imo brevissime incurvata, et hinc *cotyledones* 2 magnas, erectas, crassifoliaceas, parallele plicatas, æquilongas suffulciens.

Arbor *in insulis Maris Pacifici vigens*; folia *majuscula, cuneato-oblonga, brevissime petiolata, glaberrima*; inflorescentia *terminalis, racemosa*; flores *plurimi, speciosi.*

Barringtonia speciosa, J. R. & G. Forster, Char. Gen. p. 76, tab. 38. f. *a*, *b*, & *c* (1776); G. Forst. Icon. ined. vol. ii. tab. 191 (1776); J. F. Miller, Icon. ined. fasc. ii. tab. 7 (1776); Linn. fil. Suppl. p. 312 (1781); Cook's Voy. vol. i. tab. 24 (1784); G. Forst. Prodr. Fl. Austr. p. 47 (1786); Kerner. Hort. Semp. vol. i. tab. 28 (1796); Guillem. Zeph. Tait. Ann. Sc. Nat. 2e sér. vol. vii. p. 358 (1837), ex MSS. J. G. Forster; Montrouzier in Mém. Acad. Lyon, vol. x. p. 309 (1858): *Butonica*, Lam. (in parte) Dict. i. 521; Illustr.tab. 590 (non 591), ex icon. Mill. iterat. (1783): *Butonica speciosa*, Dryand. in Aiton, Hort. Kew. (in parte) ii. p. 439 (1789): arbor procera, trunco crasso, erecto, ramosissimo, cortice cinereo, fusco, rimuloso; ramulis patentibus, crassiusculis, fistulosis, rugosis, pallide brunneis, sulcato-striatis, apice confertim foliosis, inferne (e foliis lapsis) late cicatricatis: foliis obovatis, apice sensim obtusatis et sæpissime emarginatis (junioribus acutioribus), infra medium subcuneatis et in petiolo lato brevissimo decurrentibus, hinc fere sessilibus, patentibus, quam latitudo duplo longioribus, integerrimis, subcoriaceis, supra profunde viridibus, siccis fuscis, nervis remotis, flavidis, paullo divaricatis et arcuatim nexis, costam versus prominulis, subtus paullo pallidioribus, costa prominente, imo sensim incrassata, et rubicunda: inflorescentia terminali, erecta, thyrsoidea, 3–20-flora; floribus amplis, speciosissimis, alternatim evolutis; rachi crassa, subangulata; pedicellis subsparsis, subpatentibus, longis, validis, apice incrassatis, imo bractea foliosa cuneato-rotunda integra sessili munitis; calycis limbo majusculo, ovato-globoso, apice mucronato, integre clauso, pedicello ter breviore, demum in lobos 2 æquales parallele nervosos concavos patentes rupto; petalis 4, triplo longioribus, obtuse oblongis, expansis, candidissimis, marginibus revolutis, imo roseo-tinctis, unguibus tubo staminifero agglutinatis; staminibus numerosissimis, imo in tubum monadelphum coalitis; filamentis petalis duplo longioribus, divergentibus, candidissimis, apice roseis; antheris parvis, luteis; disco epigyno, late pulviniformi, margine externo tubum staminigerum fulciente, interno in tubum angustum erectum longiusculum apice denticulatum styli basin vaginantem expanso; stylo subulato, tenui, candido, apice sanguineo, staminibus vix longiore; ovario infero, turbinato, 4-loculari, ovulis in quoque loculo 2–3 ab axi radiantibus: drupa maxima, obpyriformi, calyce coronata, superne conice angustata, inferne rotundata, sub-4-gona; pericarpio lævi, viridi, sicco rufo-fusco, crassissimo, solide carnoso; endocarpio osseo, nuciformi, ovato, extus fibris validis lignosis tecto, intus 4-loculari, loculis sæpius monospermis; seminibus ovato-globosis, rugosis, cerasi magnitudine,

embryone dicotyledoneo generis. In insulis Societatis, Amicorum, et Nova Caledonia: *v. pl. s. in herb. Mus. Brit.* Tahitia, Tonga (*Forster*, pl. typica); *fructus non vidi.*

The above imperfect specimen from the Banksian collection is fortunately preserved in the British Museum.

The leaves in this specimen and in Forster's drawings are 7–10½ in. long, 3¾–5 in. broad, and almost sessile, are crowded at the end of the branches, scarcely 3 lines apart. The terminal raceme is from 6 inches to near a foot long; its thick erect rachis bears from 3 to 20 flowers successively developed, the upper ones (in bud) being only one third of the size of the lower or full-grown ones; the pedicel when full-grown is 5 in. long, 1½ line thick below, increasing to 3 lines in thickness, at the base of which is a foliaceous bract 2 in. long, 1 in broad. The limb of the calyx in the full-grown bud, is quite closed at the summit, is 4 in. long, 9 lines in diameter, and splits open into two large concave expanding lobes, which are marked by strong parallel nerves, and, with the style, are persistent on the fruit; the petals are pure white, 1½ in. long, 1 in. broad, and reflected; the stamens are 3 in. long, united at their base into a tube 4 lines long, 6 lines in diameter; the style is the length of the stamens; the turbinated 4-celled ovary is 6 lines long; the epigynous disk, crenulately pulvinate, is 6 lines in diameter, bearing on its outer margin the staminiferous tube, while its inner margin is prolonged into an erect tube ¾ in. high, narrowing upwards into a pluridentate open mouth, thus concealing the lower part of the style, a section of which is shown in Miller's drawing. The fruit, exclusive of the calycine limb, is 4 in. long and 3¼ broad below the middle. The ovate nut is 4-celled, each cell containing a single seed, which in Forster's drawing is 8 lines long, 6 lines broad, showing a terete radicle of its whole length, turned up at base to support two erect fleshy plicated cotyledons, as I have seen in *Planchonia.*

This plant (which is here shown in Plate X., taken from Forster's drawings) must not be confounded with Solander's species, nor with that of Linnæus, as it has hitherto been. The fruit is called *Futu* by the natives, and, like many others of the same family, is poisonous and used to stupify fish in order to catch them.

Seemann mentions (Pl. Vit. p. 83) the fruit of a similar kind, and probably another species, called in Fiji *Vutu-dina* (genuine Vutu). He did not see it; but it was said to be larger, its exterior portion soft, containing a nut so hard as to require a sharp instrument to open it in order to get to the seeds, which are edible, thus differing from Forster's species. This may probably be the species described by Montrouzier under the name of *Barringtonia speciosa,* which he found in the island Art, near New Caledonia. Although he mentions nothing of the shape of the leaves nor the character of its inflorescence, he gives a full account of its floral structure, which is similar in general details to Forster's plant, but differs in its petals, which are not longer than the calycine lobes; the stamens, too, are shorter; the petals, though white, have a roseate hue, with their margins revolute; the inner margin of the disk seems to differ in being shorter and more urceolate in form, and fimbriate (not dentate) on its margin; the ovary is 4-locular; and he noticed at the base of three of the cells 4 ovules.

To the plate of *Barringtonia speciosa* in Miller's showy book no information is attached,

and it is little more than a copy of Forster's drawing; so also is the plate given in the narrative of Cook's first voyage, and in a wrong place, with an apology from the editor for the omission of any details.

There are some circumstances in the history of this species in relation to the two Forsters that are deserving of notice. John R. Forster, a botanist of some standing, and a friend of Linnæus, was appointed to the 'Resolution' in 1772, on the second voyage of Cook, as botanist to the expedition, with the assistance of his son George, then only seventeen years of age, as draughtsman. After three years' absence they returned to England in 1775. It was previously agreed that the two Forsters should describe the history of the voyage, the profits of which were promised to them. On presenting the first portion, the Lords of the Admiralty would not sanction it unless many obnoxious passages were expunged. This the Forsters refused to do, and withdrew in disgust, the elder to Germany in 1776, where he was appointed Professor of Natural History at Halle, remaining there till he died in 1798. His son George at the same time retired to become Professor at Cassel, and afterwards to Mayence as librarian to the Elector; here entering into the excitement of the French revolution, he went to Paris as deputy to the National Assembly. During his absence the Germans stormed and took Mayence, when all his books and papers were lost, and, bereft of all his property, he left France in despair and went to India, where he died in 1794. Bearing in mind these dates, we find that Linnæus published the diagnosis obtained from the younger Forster a year after his return from his voyage, and in the same year that Forster's 'Char. Gen.' was published. In that work the new genus *Barringtonia* has as its synonym the *Butonica* of Rumph, tab. 114; that was adopted by Linnæus with the addition of another synonym, *Mammea asiatica*, Linn. It is worthy of remark that in that copious diagnosis no notice is taken of the singular nectary, which forms one of the most peculiar features of the genus; on the other hand, in the details of the species, said by Guillemin to be in the handwriting of Forster, this nectary is fully described, and the synonyms above mentioned are also given. The character of the fruit, especially of the seed, as given by the Forsters in their 'Char. Gen.,' is there wholly suppressed, and in its place a description of that of Rumph's *Butonica* is substituted. Another reference is given, to DC. Prodr., published many years after the death of the two Forsters. We may therefore infer that there has been a little tampering with the original MS. in both cases, apparently to suit the views of other persons.

Kerner in 1796 published a beautiful drawing of *Barringtonia speciosa*, copied from that of G. Forster; but he added to it the fruit of Rumph's *Butonica*, tab. 114, instead of the fruit and seed so clearly figured by the two Forsters. This plate is accompanied by a description copied from that of the younger Linnæus.

Van Houtte (Fl. Serr. vol. iv. tab. 409) published coloured drawings purporting to represent *Barringtonia speciosa*; but these were copied from Paxton's without acknowledgment; this I have noticed more particularly under *Agasta asiatica*. Four years later he published (*op. cit.* vol. vii. p. 23) a monograph of the *Barringtoniaceæ*, assumedly from the pen of Blume, where, beginning with *B. speciosa*, he gives to it a whole page of synonyms and references belonging to numerous other species, including

many of *Butonica* and *Stravadium* confounded with it, a list which I feel assured never received the sanction of Blume.

The before-mentioned form only a portion of the many complications in which *Barringtonia speciosa* has been involved by authors; several others are exposed in the sequel.

2. Agasta.

A few of the species referred by authors to *Barringtonia* differ from that genus so essentially, and are so uniform in their structure, that I propose to unite them into a new genus, *Agasta*[1]. I have selected as the type the magnificent species first collected by Dr. Solander in 1769 at Otaheite, when he accompanied Capt. Cook in his first voyage round the world. This plant, scarcely known to botanists, is well represented in Parkinson's inedited beautiful drawings, and is copiously described by Solander in his unpublished notes preserved in the British Museum, where he gives a full account of its floral and carpological characters. The genus agrees with *Barringtonia* in its large thyrse-like raceme of splendid flowers, in its extremely large vesicoid calyx, entire and undivided in the bud, subsequently splitting into two lobes by the pressure of the growing petals and stamens; but it differs from that genus in the development of its large fruit, and the entirely dissimilar structure of its seed. Solander, in his notes, gives an exact detail of this development, showing that the seed is much larger, occupying the entire space of its single fertile cell, being egg-shaped, consisting of an exalbuminous solid embryo, of mesopodal structure, as before described (*ante*, p. 53), and which is found in most of the genera of this family.

Agasta, nob.

Barringtonia auct.; *Butonica*, Soland. (non Rumph.); *Mammea* (in parte), Linn.

Calycis adnati *limbus* maximus, ovato-oblongus, parallele nervosus, in alabastro integer et omnino clausus, demum in lobos 2 concavos ruptus, in fructu persistens. *Petala* 4, lobis calycinis 3–4plo longiora, cuneato-oblonga, unguibus tubo staminigero affixa et cum illo caduca. *Stamina* numerosissima, pluriseriata, imo in tubum brevem monadelpha; *filamenta* filiformia, petalis longiora; *antheræ* parvæ, bilobæ, lobis adnatis, paullo supra basin dorso affixis, rima longitudinali dehiscentibus. *Stylus* filiformis, longitudine staminum, persistens; *stigma* parvum, simplex. *Discus* epigynus, pulvinatim annularis, margine exteriore tubum staminiferum fulciens, interiore in urceolum brevem erectum productus. *Ovarium* inferum, turbinatum, vertice intra discum circa stylum cavato, 4-loculare; *ovula* in quoque loculo 2 vel plura, apice funiculo brevi suspensa. *Fructus* majusculus, conice vel depressius obpyriformis, 4-gonus, lævis, calyce coronatus: *pericarpium* crassissimum, spongioso-carnosum; *endocarpium* coriaceum, extus fibris numerosis lignosis tectum, intus abortu 1-loculare, cum loculis marcidis 3 in chorda longitudinali prominente eo affixa signatum, monospermum: *semen* magnum, loculo conforme; *testa* submembranacea, endocarpio adhæsa; *embryo* exalbuminosus, solidus, eburneus, chordæ impressione longitudinaliter canaliculatus, mesopodus.

Arbores *Asiaticæ, aut in insulis Oceani Pacifici vigentes, altæ, ramosissimæ:* folia *maxima, in apicibus ramorum conferta, oblonga, breviter petiolata, alterna:* thyrsus *terminalis:* flores *speciosissimi, alterni:* pedicelli *longi, apice incrassati, imo* bractea *foliosa decidua muniti:* fructus *viridis, siccus brunnescens, nitidus.*

[1] From ἀγαστὸς, *admirandus*.

1. Agasta splendida, nob.: *Butonica splendida*, Soland. Prim. (ined. 1769), p. 282[1]; in Obs. MSS. Soland. (ined.), p. 382 (excl. synon.); Parkinson, Icon. ined. vol. ii. tab. 68 et 69: *Butonica speciosa*, Dryand. in Aiton, Hort. Kew. 1st edit. (1789), vol. ii. 439 (excl. syn.): arbor elegantissima, ramis late expansis: foliis maximis, sparsis, patentibus, latissime obovatis, supra medium hemisphæricis, basin versus cuneatis, in margine cartilagineo integerrimis, subcoriaceis, planis, in junioribus ovalioribus obtusis et sæpe emarginatis, supra nitidis, intense viridibus, siccis pallidioribus, nervis paucis valde remotis prominentibus, subtus pallidioribus, nervis venisque reticulatis paullo prominentibus, costa imo incrassata, rubicunda; petiolo vix ullo, cum glandula supraaxillari longe supra folii insertionem in ramo distincta: racemo in ramulis novellis terminali; rachi valida, haud longa, compresse angulata; floribus maximis, speciosissimis, sparsis; pedicellis 1-floris, teretibus, crassis, longiusculis, imo foliolis seu bracteis majusculis 2 v. 3 obtuse ovatis concavis æqualibus patentibus persistentibus munitis; limbo calycino in alabastro maximo, ovato, integre clauso, demum in lobos 2 concavos parallele nervosos rupto; petalis 4, magnis, albis, 3plo longioribus, ovato-oblongis, subacutis, expansis: staminibus numerosissimis, pluriseriatis, imo breviter monadelphis, expansis, infra niveis, apice saturate rubris; disco styloque ut in char. gen., intus breviter elevato: ovario infero, turbinato, vix angulato, 4-loculari, vertice intra discum concavo; ovulis plurimis in quoque loculo suspensis: drupa magna, obpyriformi, vix 4-gona, apice sensim constricta et calyce coronata; pericarpio crasso, nitido, viridi-brunnescente; mesocarpio spongiose carnoso; endocarpio coriaceo, fibris lignosis tecto, abortu uniloculari et monospermo, dissepimentis hinc in chordam crassam contractis et ad parietem adpressis; semine magno, oblongo, obtuse 4-gono; testa tenuiter coriacea, molliuscula, albo-incarnata; nucleo albo, sapore astringente, structura forsan aliorum. In insul. Otaheite: *v. pl. s. in hb. Mus. Brit.* Tahiti (*Solander*); *fruct. non vidi.*

This species (here shown in Plate XI., taken from Parkinson's drawing) was collected by Solander during his three months' residence in Otaheite, when he accompanied Capt. Cook on his first voyage to the Pacific in 1769, to observe the transit of Venus; he found it also in the adjacent islands of Huabeine, Ulaietea, and Otaha. He describes it as a magnificent tree, 50 feet high, with a broad expanded head; its copious very large shining leaves, its splendid flowers, measuring 8 in. in diameter, interspersed with large bright pendent fruits, altogether form objects unsurpassed in beauty, and superb ornaments to the forests in the interior of the islands. By the natives it is called *Ahuta* (*Æhutu*). Dryander, from Solander's manuscript, regarded it as belonging to the *Butonica* of Rumph; but subsequently (in 'Hort. Kew.') he considered it identical with the *Barringtonia speciosa* of Forster, collected in Capt. Cook's second voyage, a plant evidently only known to him from Forster's drawings. Solander's plant, though offering a general similarity to the latter, differs from it in its

[1] Primitiæ Floræ insularum Oceani Pacifici, sive Cat. plant. in Otaheite, Eimeo, Otaha, Huaheine et Ulaietea, 1769, diebus 13 Apr. ad 9 Aug. collectarum; Solandri manuscriptæ in Libr. Banks. Musæo Britannico,—a work of great value, never published, and but little known. Parkinson's coloured drawings of the same plants, also unpublished, were made to illustrate that work.

much larger leaves, its flowers of greater size, on a longer raceme and on stouter pedicels, bracteated in the middle, larger calycine lobes, the presence of a large peculiar gland above the insertion of each leaf, and more especially by the different structure of its fruit and seeds. This last consideration places the two plants in distinct genera. Parkinson's exquisite coloured drawing gives an excellent representation of Solander's plant, but shows only the upper leaves, crowded on the summit of the branches as they appeared in nature; but Solander's dried specimens show some of the lower leaves; these are 14–24 in. long, $8\frac{1}{2}$–12 in. broad, quite round at the apex, cuneated below into a broadish obsolete petiole, or expansion of the midrib. Solander states that an inch or less above the insertion of each leaf a reddish obtusely conical gland is observed on the branchlets. The rachis of the terminal raceme is stout; the pedicel of each flower, 6 in. long, $\frac{1}{4}$ in. thick, bears in its middle a leaf-like sessile bract $2\frac{1}{2}$ in. long, 1 in. broad; the adnate portion of the calyx is $\frac{1}{2}$ in. long; the upper portion splits into two large concave lobes, with parallel nervures $1\frac{1}{4}$ in. long, $\frac{1}{2}$ in. broad; the petals are $3\frac{1}{2}$ in. long, $1\frac{1}{8}$ in. broad; the stamens, spreading in all directions, are agglutinated at the base into a monadelphous tube 4 lines long, 8 lin. in diam., seated upon the outer margin of the disk, the slender filaments being 5 in. long; these, with the petals attached, soon fall off together; the subulate persistent style is longer than them. The fruit is 4 in. long, $2\frac{3}{4}$ in. broad below the middle, is crowned by the persistent calyx, disk, and style. The thick pericarp encloses a single seed, covered by a thin soft coriaceous testa, the nucleus, homogeneous in texture, being white, oval, obsoletely 4-angled, the size of a pheasant's egg; this is not edible, owing to its astringent flavour. In a note by the editor of 'Cook's Voyages' (p. 157), it is stated that the plant is used by the natives of Otaheite to catch fish by intoxicating them.

2. Agasta asiatica, nob.: *Mammea Asiatica*, Linn. Sp. Pl. i. p. 501 (1753); Osb. Itin. (1752), Voy. China, Engl. edit. 2, p. 62 (1771): *Stravadium macrophyllum*, Bl. in Van Houtte, Fl. Serr. vii. p. 24: *Barringtonia macrophylla*, Miq. Flor. Ind. Ned. i. p. 491: *Barringtonia speciosa*, Linn. fil. Suppl. p. 312 (1781); Gaud. in Freyc. Voy. p. 482 (non Forster); Guillemin (in parte), in "Zephyritis Taitensis," Ann. Sc. Nat. 2nd ser. vol. vii. p. 358 (1837); Paxton (non Forst.), Mag. Bot. x. p. 241 (cum icon. color.); Blume (non Forst.) in Van Houtte, Flor. Serr. vol. iv. p. 409, cum icon. color. (ex icon. Paxt. clept.); Benth. (non Forst.), Lond. Journ. Bot. ii. 221; Flor. Austr. iii. p. 221; Seem. (non Forst.), Flor. Viti. i. p. 82; Lindl. Veg. Kingd. (ex Paxton), p. 755, fig. 503 *: arbor grandis, late frondosa, ramulis pendulis, crassis, striatis, rufo-brunneis, pruinosis, fistulosis: foliis maximis, congestis, elongato-oblongis, apice late ovatis, rotundatis vel obtusioribus, infra medium sensim angustatis, acutis, vel sæpius circa petiolum rotundato-truncatis, integerrimis vel subrepandis, chartaceis aut subcoriaceis, supra nitidis, pallide viridibus, nervis divaricatis arcuatim nexis, venis transversis reticulatis, costa plana, imo sensim incrassata, subtus pallidioribus, flavescenti-brunnescentibus, opacis, costa nervisque rubidulis, prominentibus; petiolo brevissimo, lato, supra plano, limbo

60plo breviore: racemo terminali, spicatim plurifloro, rachi crassa suberecta; floribus alternis, speciosis; pedicellis validis, longiusculis, apice crassioribus; calycis limbo maximo, primum oblonge globoso, integre clauso, parallele nervoso, demum in lobos 2 oblongos concavos fuscos minute granulosos rupto; petalis 4, duplo longioribus, obtuse oblongis, albis; staminibus sanguineis, disco styloque ut in char. gen.; ovario infero, turbinato, late 4-gono, 4-loculari ovulis in quoque loculo 5–6, suspensis: fructu majusculo, pyramidato, acute 4-gono, calyce coronato, imo umbilicato et cordatim truncato, abortu 1-loculari et monospermo; pericarpio crassissimo, spongioso; endocarpio extus fibris lignosis crassiusculis intricatis tecto; embryone mesopodo. In Malacca, Java, Australia, insulis Maris Pacifici et Mauritianis: *v. s. in herb. Mus. Brit.* Java (*Horsfield*), in ins. St. Helena cult. (*Home*); *in hb. Hook.* Sincapoor (*Anderson*), Australia (*Hill*), Fiji (*Barclay* 3427), Fiji (*Seemann* 148), in ins. Maurit. (*Blackburn*), in ins. Mohelle (*Meller*); *in herb. Soc. Linn.* Penang (*Wall. Cat.* 3632 A), Sincapore (*Wall. Cat.* 3632 B), Cambodia (*Wall. Cat.* 3632 D): *v. fruct. in Mus. Brit. et Kew.*

Linnæus never saw this splendid plant, but described it in 1753 from the excellent materials furnished by Osbeck, who first observed it in 1752 upon an island near Java. Osbeck says it is a good-sized tree, often procumbent, with wide-spreading branches, hanging over the maritime shores or in the estuaries of rivers. He relates that he had much difficulty in collecting a specimen, owing to the furious attack of ants, which in myriads live in its fistulose branches. The younger Linnæus, in 1781, five years after the date of Forster's 'Genera,' and after his retirement to Germany, published a full description, purporting to be that of the *Barringtonia speciosa*, Forst., as obtained from Forster, and giving as its synonyms very different plants, the *Mammea asiatica* of Osbeck, the *Commersona* of Sonnerat, and the *Butonica* of Rumphius (tab. 114). Copying Rumphius, he states it to be a lofty tree, at the same time that he took the description of the leaves and inflorescence from Osbeck's details. A singular coincidence here occurs: his long diagnosis is in many parts a copy, word for word, of Forster's MSS description of his *Barringtonia speciosa* existing in the Paris Museum, according to Guillemin; but the diagnosis of Linnæus omits all mention of the peculiar nectary and the unusual features given by Forster of the fruit and seeds—characters that serve above all others to distinguish the two species as belonging to distinct genera. As it now stands, Linnæus's diagnosis may be taken as a fair account of *Agasta asiatica*; but as a description of *Barringtonia speciosa* it must be absolutely rejected.

Osbeck states that its leaves are obovate, and more than 1 foot long; Horsfield's specimens agree in form, are 15 in. long, 7 in. broad, on a petiole 3 lines long, 2 lines broad. The specimens from Penang, Singapore, Cambodia, and other places above quoted, all accord in nearly similar dimensions and in the same length of petiole; but Blume states that in his plant the leaves are 10–20 in. long, 5–8¼ in. broad, on petioles 5–6½ lines long—probably a mistake.

We have, however, an admirable account of this plant, introduced into Salisbury in a living state under the name of *Barringtonia speciosa.* The main leaves grew to a length of more than a foot; but the upper leaves became gradually smaller. The plant flourished

thirteen years, growing to the height of 8 feet; and it became necessary to cut off its top for the length of a foot, which cutting, when planted in a pot, grew rapidly, and produced a terminal thyrsoid inflorescence 22 inches long, from which the drawing of one of the flowers of the natural size, together with its floral leaf, was published by Paxton in 1843. This terminal inflorescence was 18–24 in. long, with axils about 1 in. apart. The floral leaf is figured as 9 in. long, 3 in. broad, almost sessile; in the axil of each leaf a single large pedicellated flower originates. The lower pedicels of the full-grown flower are 2 in. long; these gradually diminish in size to $\frac{3}{4}$ in., supporting the young buds: the pedicels are stout and erect, each bearing on its summit the inferior ovary, crowned by the limb of the calyx, divided into two concave lobes nearly $1\frac{1}{2}$ in. long. It has 4 white petals, 2–$2\frac{3}{4}$ in. long, $1\frac{1}{4}$–$1\frac{1}{2}$ in. broad, attached by their claws to the staminiferous tube; the filaments, of a sanguineous purple, are 3–$4\frac{1}{2}$ in. long; the style is 4–5 in. long. Only one flower blossomed at one time, which fell off next morning, when it was followed by others in succession. This account was published in 'Paxton's Magazine.'

Van Houtte in 1848 copied the two drawings of Paxton in his 'Flore des Serres' without acknowledgment, leading us to suppose they were made from a plant cultivated in Belgium. He omitted all the interesting observations of Paxton, but gave a description of it, copied word for word from Rumphius's account of his *Bútonica*, also without the least mention of the source from which it was taken.

This plant was introduced into the island of St. Helena prior to 1780, where it flourished in the garden of the Governor, and probably still exists there, as we know it was living a few years ago.

The fruits in our museums are without localities; but those of this species are recognizable from those of *A. indica* by their larger size, their more regular pyramidal quadrate form with rounded angles, and more truncated (not cordate) base. The largest specimens I have seen are $4\frac{1}{2}$ in. long, $3\frac{1}{2}$ in. broad at the sides; others are $3\frac{1}{2}$ in. long: the pericarp is polished, and of a pale colour, is very thick and spongy; the endocarp is coriaceous, and is covered outside by ligneous fibres, which extend from the style to the top of the pedicel; a large exalbuminous embryo fills the cell, is $2\frac{3}{4}$ in. long, $1\frac{1}{2}$ in. broad, and in a transverse section shows a vacant space between the exorhiza and neorhiza.

Seemann states that these large fruits are used by the natives of Fiji in their games, and that they serve as floats for their fishing-nets. As in the preceding species, they are poisonous, and are used to catch fish by stupifying them. In Fiji these fruits are called *Vutu*, in the Tonga islands *Futu*, in the Pacific islands *Hutu*, *Hootu*, in Amboyna and Java *Huttum*. Seemann adds that this species in Fiji is a magnificent sea-side tree, and that it furnishes the material *liku*, of which the women's dresses are made.

The analysis of the flower and fruit of this species is shown in Plate XII.

3. Agasta indica, nob.: *Barringtonia speciosa*, W. & A. (non Forst. nec Roxb.), Prodr. Fl. Penins. p. 333 (excl. syn.); Wight, Icon. tab. 547 (excl. fig. fruct.); Thwaites, Enum. p. 119; *sine nomine* in Hermann, Icon. ined. tab. 241: arbor, ramulis crassis, cicatricatis, 4-angulatis, pallide brunneis, fistulosis; foliis oblongis, apice gradatim obtusis, infra medium angustioribus, imo anguste rotundato-truncatis, marginibus cartilagineis integris, chartaceis, supra lucentibus vel sub-

opacis, pallide viridibus, nervis patentim divaricatis, costa plana imo sensim incrassata, subtus pallidioribus, opacis, nervis costaque prominentibus; petiolo brevissimo, late sulcato: racemo terminali, thyrsoideo, erecto, folio breviore; floribus majusculis, speciosis; pedicellis longis, teretibus, divaricato-erectis, imo bractea foliosa acute oblonga caduca munitis; calycis limbo magno, primum oblongo et integre clauso, parallele nervoso, demum in lobos 2 concavos rupto; petalis 4, duplo longioribus, acute oblongis, concavis, suberectis; staminibus numerosissimis, ista excedentibus ; disco intus urceolatim expanso styloque ut in char. gen.; ovario infero, turbinato, sub-4-gono, 4-loculari, ovulis in quoque loculo 6, axi superne affixis: fructu majusculo, calyce coronato, subglobose 5-angulato, apice subito attenuato, angulis acutissimis in lobis basalibus continuis, imo plus minusve profunde cordatis et umbilicatis; cæteris ut in specie precedente. In India orientali et Ceylonia indigena; in insulis Comorinis et in Mauritio forsan introducta: *v. s. in hb. Soc. Linn.* Madras (*Wall. Cat.* 3632 c); *v. fructus in Mus. Kew.* Comorin (*Kirk*).

A tree of moderate size, with wide-spreading branches, at the extremities of which the leaves are approximated at a distance of 3 lines; the leaves vary in size from 4½–12 in. long, 2¼–7 in. broad, on petioles 1–2 lines long and broad: the rachis of the raceme is 3½ in. long; the lower pedicels 2½ in. long. the upper ones in bud gradually much shorter, the basal bract in the former 1¼ in. long, 5 lines broad; the calycine lobes are 1 in. long; the petals 1¾ in. long, 1 in. broad, falling off attached to the staminiferous tube; the filaments are 2 in. long; ovary 5 lines long. The fruit figured by Wight does not belong to it; he confesses that he never saw it, but copied it from Gaertner's tab. 101, which belongs to a very different plant—*Butonica Rumphiana*, from the Dutch Asiatic settlements, and the fruit of which accords with Sonnerat's drawing of it. The fruit of the Indian species may be recognized by comparison with Hermann's drawing of it; the largest specimens in the British Museum (locality not cited) are 4¼ in. long, 4½ on the sides, 5¾ in. across the angles, the cordate basal lobes extending ½ in. below the attachment upon the pedicel. Kirk's specimen from Mohille is similar in shape, but only half that size; that in Hermann's drawing is intermediate in size, and similar to others in the British-Museum collection.

This handsome well-marked species is distinguished from the two preceding by its more oblong leaves, shorter racemes, with smaller flowers, shorter petals, and by the shape of its fruit. The upper leaves in Wight's plate 547 agree in size and shape with those in Hermann's drawing; but the lower leaves are gradually much larger.

The specimen of the fruit found by Dr. Kirk on one of the Comorin Islands was probably floated by sea from the Indian coast, as Commerson and Sonnerat relate, and is known by the name of "*Bonnet rouge*."

The floral and carpological features are shown in Plate XII.

3. Butonica.

This genus was first described in 1744 by Rumphius[1], was acknowledged by Lamarck in 1783[2], and by Jussieu in 1789[3]; but the younger Linnæus, in 1781, united it with the

[1] Amboyn. v. p. 179. [2] Dict. Méthod. i. 521. [3] Gen. Pl. p. 326.

Barringtonia of Forster[1]. His example was followed by DeCandolle in 1728[2], and by all succeeding botanists, which has greatly contributed to the confusion at present existing. The genus differs from *Agasta* very conspicuously: its leaves are more chartaceous, and serrated on the margins (not coriaceous and entire); its inflorescence is an elongated pendulous many-flowered spicated raceme (not erect and thyrsoid with few, very large flowers); the flowers are smaller, on much shorter slender pedicels, with a calyx always conspicuously smaller, globose, and splitting into 3, rarely 4 lobes (not long, oval-oblong, and rupturing into two large concave lobes). It consists of several arborescent species, growing inland in moist places, or in estuaries on the sea-shores. The leaves are generally large, more or less acute and cuneated, and the racemes very long, with handsome flowers. The fruit, in structure, resembles that of *Agasta*, and, owing to its thick spongy pericarp, is often found floating at sea along the Malayan coasts; they are also often found upon the coasts with the seeds germinating within the pericarp, after the manner shown by Roxburgh[3].

BUTONICA, Rumph., Lam. et Juss.

Barringtonia, Linn. fil. (in parte) et alior.; *Stravadium* (in parte), DC.; *Commersona* et *Menichea*, Sonnerat.

Calycis adnati *limbus* mediocris, in alabastro globosus, integre clausus, mucronulatus, parallele nervosus, demum in lobos 3 vel 4 ruptus, viridis, persistens. *Petala* 4, triplo longiora, oblonga, unguibus tubo staminigero adglutinata et cum illo caduca. *Stamina* numerosissima, pluriseriata, imo breviter monadelpha, iis *Barringtoniæ* similia. *Discus* epigynus, plane aut pulvinatim annularis, margine exteriore tubum staminigerum fulciens, interiore in osculum elevatum expansus. *Stylus* et *stigma* ut in *Agasta*. *Ovarium* inferum, turbinatum, 4-loculare; *ovula* in quoque loculo 2 vel plura, ab axi vel summo suspensa, anatropa. *Fructus* majusculus, cylindricus, ovatus, pyramidatus aut obpyriformis, obsolete vel acute 4-gonus, aut 6-sulcatus cum alis 6 crassis pendentibus, apice subattenuatus et calyce coronatus, indehiscens: *pericarpium* nitidum, crassissimum, spongioso-carnosum; *endocarpium* tenuiter coriaceum, extus fibris numerosis lignosis tectum, intus abortu 1-loculare, cum loculis marcidis 3, in *chorda* longitudinali prominente eo affixa signatum, monospermum: *semen* magnum, loculo conforme; *testa* submembranacea, endocarpio adhæsa; *embryo* exalbuminosus, solidus, amygdalinus, sæpe edulis, ovatus, chordæ impressione longitudinaliter canaliculatus, interdum striolatus, mesopodus.

Arbores *Asiaticæ, et in insulis maris Pacifici indigenæ, ramosissimæ, ramulis sæpe fistulosis*: folia *plerumque majuscula, oblonga, sæpius utrinque acuta, plus minusve serrata, brevissime petiolata*: racemi *terminales, longi, spicati*; flores *speciosi, breviuscule pedicellati*: fructus *majusculus, forma varia, nitidus, lævis, sæpius ruber*.

1. BUTONICA ALBA, Rumph. Amb. v. cap. 30, p. 181, tab. 116 (ubi planta valde diminuta): *Stravadia alba*, Pers. Ench. i. p. 30: *Stravadium album*, DC. Prodr. iii. p. 289: *Barringtonia alba*, Bl. in V. Houtte, Fl. Serr. vii. 24; Miq. Fl. Ind. Ned. i. 485; Hask. Bot. Zeit. xxvii. p. 598: *Barringtonia conoidea*, Griffith, Notulæ, p. 656; Icon. Pl. Asiat. tab. 635. fig. 1 ad 18 (plant. et flor. analysis) et tab. 634 (in parte quoad semen?): arbuscula, ramulis crassiusculis, rugosis, subsulcatis, fistulosis,

[1] Linn. fil. Suppl. Sp. pl. p. 312. [2] Prodr. iii. p. 288. [3] Wight, Icon. i. tab. 152.

e foliorum lapsu cicatricatis: foliis majusculis, elongato-oblongis, apice sensim aut repentius acuminatis, infra medium subcuneatis, imo acutis vel circa petiolum anguste rotundato-truncatis, marginibus cartilagineis undulato-revolutis, crenato-serratis, chartaceis, supra viridibus, opacis, sub lente impresso-rugulosis, nervis tenuibus arcuatim nexis prominulis, reticulatis, subtus pallide brunnescentibus, minutissime granulatis, costa striolata imo sensim crassiore, nervisque pallidissimis prominulis; petiolo crasso, semitereti, limbo 12–20plo breviore: racemis elongatis, pendulis, minute velutinis, floribus speciosis subsparsis, pedicellis imo articulatis et 2-bracteolatis; calycis limbo subparvo, globoso, demum in lobos 3–4 rupto; petalis 4, fere triplo longioribus, oblongis, lateribus retroflexis, carnosulis, albis; staminibus, disco styloque ut in char. gen.; ovario infero, subcylindrico, 8-sulcato, 4-loculari, ovulis in quoque loculo 2 apice suspensis: fructu ovali, utrinque rotundato, obsolete 4-gono, calyce coronato, abortu 1-loculari et monospermo; pericarpio viridi, crassissimo; endocarpio coriaceo, extus fibris lignosis tecto; testa tenui, cum raphe ramosa parallele nervosa; embryone mesopodo, solide eburneo, 4–8-sulcato. In Malacca et ins. Archipel. Asiat. in fluviatilibus: *v. s. in hb. Hook.* Mergui (*Griffith*), Malacca (*Maingay* 760); *in hb. Soc. Linn.* Sincapore (*Wall. Cat.* 3632 B), Penang (*Wall. Cat.* 3634 B et 3634 D), in hort. Sundriban cult. (*Wall. Cat.* 3634 A).

The above specimens agree well with the description by Rumphius of his *Butonica alba*, the drawing of which in his plate 116 is on a scale so reduced as to give little idea of its character, all the parts being diminished to one fifth of their natural size. Griffith's plant quite accords with the description; but in his plate the leaves and flowers are reduced to half their natural size; his manuscript details are very good and ample, and the analysis of the flower in its natural size is quite complete; his figs. 13–17 show sections of the ovary, much magnified. Rumphius says its leaves are 18 in. long, 5–6 in. broad, with obsoletely crenulate margins, pallidly fuscous below, with raised white nerves; racemes 2–3 feet long; calyx divided into lobes; white petals, white stamens, reddish at base; fruit pome-shaped, 3 in. long, 2 in. broad, deep green colour, marked by areolar impressions; nucleus white, not edible. The above diagnosis is framed upon Griffith's specimen and drawing; here the leaves are $10\frac{1}{2}$–$12\frac{1}{2}$ in. long, 4–5 in. broad, on thick petioles 3-4 lines long (shown half size in his drawing); raceme 1–2 feet long, slender pedicels 4–6 lines long; bracts nearly 1 in. long, very caducous; calyx globular in the bud, and 4 lines in diam., splitting at first into 2, then into 4 lobes; petals 10 lines long, 5 lines broad; the oval fruit is 3 in. long, 2 in. broad, with a pericarp 2–3 lines thick; seed oblong, tapering to its suspended summit, 15 lines long, 10 lines broad. This seed appears represented in some of the figures of Griffith's plate 634, there being no room for it in his plate 635 (see under *Careya sphærica*). In the memorandum attached to his specimen, he says the solitary seed is suspended, with a very thick coriaceous integument, is sulcate outside; its embryo is homogeneous, agreeing with the figures above mentioned. Its analysis is shown in Plate XIII.

2. BUTONICA RACEMOSA, Juss. Gen. 326 (excl. syn.): *Eugenia racemosa*, Linn. Sp. Pl. 673; Fl. Zeyl. 191 (excl. syn.); Lam. Dict. iii. 197 (excl. syn.): *Jambos sylvestris Saam-*

stravadi, Rheede, Hort. Mal. iv. p. 11, tab. 6; Willd. Sp. Pl. ii. 966 (excl. syn.); *sine nomine*, Hermann, icon. ined. tab. 212, 213 & 239: *Barringtonia racemosa*, Bl. (non Gaud.) in DC. Prodr. iii. 288 (excl. syn.); Roxb. Fl. Ind. iii. 634 (exclus. syn. in parte); W. & A. Prodr. Fl. Ind. i. 133 (excl. syn.); Wight, Illustr. p. 19; Wight, Icon. tab. 152 (excl. fruct. fig.); Hook. Bot. Mag. tab. 3831; Wall. Cat. 3684 D; Thwaites, Enum. Pl. Zeyl. (excl. var. β), p. 119: arbor alta, ramosa, trunco recto; ramis crassis, cylindricis, e foliorum lapsu crebre cicatricatis; ramulis tenuibus pendentibus: foliis lanceolato-oblongis, infra medium ad basin gradatim angustatis, apice sensim longe acuminatis, marginibus subrevolutis, crenulato-serratis, tenuiter chartaceis, supra viridibus, nervis subpatentibus arcuatim nexis prominulis, venis transversim reticulatis, costa plana, imo latiore, subtus flavide opacis, nervis prominentibus; petiolo latiusculo, supra sulcato, late marginato, rubro, limbo 60plo breviore: racemo terminali, pendulo, glaberrimo, rachi valida, longa, spicatim multiflora; floribus speciosis, breviter pedicellatis; pedicellis imo bractea minuta caduca munitis; calyce globoso, demum in lobos 3–4 rupto; petalis acute obovatis triplo longioribus, marginibus retroflexis, flavidis; staminibus rubris, disco, styloque ut in char. gen.; ovario infero, turbinato, acute 4-gono, 2–3-loculari, ovulis plurimis in quoque loculo, ab axi radiantibus: drupa majuscula, obverse obovata, apice sensim coarctata, ubi 4-sulcata et calyce coronata; pericarpio crassissimo, extus viridi; mesocarpio albido, demum brunnescente, spongioso; endocarpio fibris lignosis tecto, abortu 1-loculari et monospermo; semine magno, oblongo, utrinque acuto, appenso, homogeneo, ab utraque extremitate germinante. In Indiæ peninsula: *v. pl. s. in hb. Soc. Linn.* Sundriban (*Wall. Cat.* 3634 A); *hb. Finlayson* (*Wall. Cat.* 3634 D).

This is described by Rheede as a tree of vast size, growing in moist woods, and by Roxburgh as a lofty tree, with a head of many spreading branches; its trunk gives a dense wood of a yellowish white colour; its leaves are 3–15 in. long, 1½–4 in. broad, on a broad petiole 3–4 lines long. The rachis of the raceme is 2 feet long, and expands to a width of 1½–2 in., with flowers ½–¾ in. apart, on pedicels 3–6 lines long; calycine lobes after expansion 4 lines long; petals 9 lines long, 4 lines broad, white; filaments 1¼ in. long, white, agglutinated at base into a tube 3 lines long. The drawing of Hermann agrees with that of Rheede as to the size and shape of the fruit, which is 3 in. long, 2¼ in. broad; that in Roxburgh's figure is similar in shape, 2¾ in. long, 2 in. broad below the middle, and shows the seed germinating within the pericarp, throwing out a young stem from the extremity near the pedicel, and a rootlet from the apex of the fruit—a development analogous to that described by Rumphius in *Butonica Rumphiana*; it shows that the seed must be suspended, and that the plumular extremity of the neorhiza points to the base of the fruit. A very good representation of the plant is given by Sir William Hooker, drawn from a specimen cultivated in Liverpool, and received from Bombay. In three years' time, when 8 feet high, it yielded flowers in a raceme 28 in. long.

Linnæus first described the species in his Ceylon Flora, on a plant not seen by him, upon the drawings of Hermann's Ceylon plants, and again in his Sp. Plant. no. 5, where he considered it to be identical with Rheede's Malabar Saamstravadi, tab. 7.

3. Butonica Rumphiana, nob.: *Butonica*, Rumph. Amb. v. cap. 29, p. 179, tab. 114 Lam. Encyl. i. 521 (excl. synon.): *Barringtonia speciosa*, Gaertn. (non Forst.), De Fruct. ii. p. 96, tab. 101 (excl. synon.); Roxb. Fl. Ind. iii. 636; Bl. (in parte), Van Houtte, Fl. Serr. vii. p. 23: *Barringtonia racemosa* auct. (in parte): *Commersona*, Sonnerat, Voy. Guin. p. 14, tab. 8 et 9: *Mitraria Commersoni*, Gmelin, Syst. p. 799: *Fructus peregrinus tetragonus*, Clus. Exot. lib. 2. cap. 5: *Stravadium rubrum*, DC. (in parte), Prodr. iii. 289: arbor, ramulis cinereis, apice crebre foliosis; foliis majusculis, elongato-oblongis, apice sensim angustioribus et breviter acuminatis, infra medium gradatim angustioribus, et imo rotundiuscule truncatis, margine serrulatis, supra profunde viridibus, nervis tenuibus costaque subimmersis, subtus pallidioribus, costa nervisque valde prominentibus; petiolo semitereti, limbo 70plo breviore: racemo elongato, pendulo, pruinoso; floribus speciosis, sparsis; pedicellis subbrevibus, bractea foliosa valde caduca munitis; calyce mediocri, globoso, demum in lobos 2, dein in 4 rupto; petalis 4, duplo longioribus, oblongis, concavis, albis; staminibus, disco styloque ut in char. gen.; ovario turbinato, 4-loculari, ovulis in quoque loculo 2 appensis: drupa mitræformi, infra medium obtuse 4-angulata, superne sensim angustata, imo truncata et umbilicata, extus rubra, aut sicca flavescente, nitida, lobis calycinis immutatis coronata. In insulis Archip. Asiat. et in Siam: *v. s. pl. in hb. Hook.* Siam (*Schomburgk*); *v. fr. s. in Mus. Brit.*

This is described by Rumphius as a lofty tree growing near the sea-shore, throwing out many spreading branches after the manner of *Terminalia Catappa*, with leaves 16–18 in. long, 4½–6 in. broad, on a petiole 1½ line long and half that breadth, all much reduced in his drawing.

In Sonnerat's drawing the flowers expanded, 2 inches in diameter, are 3 lines apart, on a stout rachis 3 in. long, with bracts 1½ in. long, 1 in. broad; pedicels 3 lines long; lengthening with the growth of the fruits, when they bend backwards; calyx in bud globose, 6 lines in diameter, splitting into four persistent lobes; petals 8 lines long; stamens 1 inch long.

The drawing of Rumphius agrees with that of Sonnerat as to the size and shape of the fruit, and is identical with that of the *Barringtonia speciosa* of Gaertner (non Forst.) in his plate 101; it is 2¼ in. long, 2½ in. broad, with quadrate sides, 4 obtuse angles, gradually contracting into a narrow neck at the summit, where it is crowned by the persistent calyx. Rumphius describes the seed as germinating within the fruit as it lies on the sea-shore, when a new shoot or stemlet first protrudes from the end, close to the pedicel, while a new rootlet is emitted from the apex, just as Roxburgh figures it in *B. racemosa*. He also mentions a kindred species from Celebes, where the fruit is the size of a child's head. Sonnerat, who gives a good account of this plant, which he found at Pulo Penang, says that its fruit is frequently found at sea, floating between the islands.

Schomburgk's specimens are referred to this species, because they agree in the size and shape of its leaves, which are 7–10½ in. long, 3–4¼ in. broad, on a petiole 1–1½ line long; the raceme is about 9 in. long, with flowers about ½ in. apart; the globular calyx in bud is 5 lines in diam., splits first into two, then into 4 lobes; the petals are 9 lines long, the ovary 4-celled. For the structural characters of this species see Plate XIII.

4. BUTONICA TERRESTRIS, Rumph. Amb. iii. lib. 5. cap. 30. p. 181, tab. 115 (pl. ad $\frac{1}{4}$ dimens. reduct.): *Barringtonia elongata*, Korth. in Kruidk. Arch. i. p. 206 (nomen solum): *Barringtonia racemosa*, Bl. (non Juss.), in Van Houtte's Flora, vii. p. 23; Miq. Fl. Ned. Ind. i. p. 486: *Barringtonia rubra*, Miq. *l. c.* p. 487: *Stravadium rubrum*, DC. Prodr. iii. 289 (excl. syn.): arbor demissa, ramulis crassiusculis, fistulosis, rufo-brunneis, pruinosis: foliis approximatis, majusculis, elongato-oblongis, apice acute attenuatis, imo spathulato-cuneatis, angustatis, et in petiolo decurrentibus, marginibus subrepandis et supra medium sinuato-serratis, dentibus obtusulis sæpe aciculato-mucronatis, tenuiter chartaceis, supra pallide viridibus, opacis, nervis adscendentibus utrinque circa 20 tenuibus prominulis et marginem versus arcuatim nexis, subtus flavide pallidioribus, opacis, nervis costaque lata striolata prominentibus; petiolo subtenui, limbo 16plo breviore: racemo terminali, pendulo, folio vix longiore; rachi subtenui, striata; floribus alternis, subremotis, breviter pedicellatis; calycis limbo mediocri, globoso, demum in lobos 3 ovatos concavos rupto; petalis 4, duplo longioribus, obovatis, rubris; staminibus, disco styloque ut in char. gen.; ovario turbinato, sub-4-gono, 4-loculari, ovulis in quoque loculo 2 suspensis: fructu oblongo, utrinque obtuso, calyce coronato, costato-4-gono, rugoso, viridi, demum flavide brunneo, abortu 1-loculari et monospermo; seminis embryone mesopodo, rotunde oblongo, obsolete 4-gono. In Java orientali indigena et in hort. Bogor. cult.: *v. s. in hb. Hook.* Banca (*Horsfield*), Patjetan (*Horsfield* 209).

The specimens above quoted accord well with Rumphius's *Butonica terrestris rubra* in the size and shape of the leaves as well as in the inflorescence, agreeing with the dimensions given in the text; but on his plate 115 the plant is reduced to a quarter of its proper size, which makes it difficult of recognition; we cannot hesitate, however, in considering them specifically identical. Rumphius describes it as a low tree, growing in gravelly soils, in woods remote from the sea. According to his account, the leaves are narrower and more flaccid than in the other plants described by him; they are acute at both extremities, obsoletely serrulate, 12–18 in. long, 3 in. broad, and petiolated; the raceme is 2 feet long, with somewhat remote flowers; the calyx is divided into 2 or 3 lobes; petals and stamens red; the fruit, crowned by the calyx, is 3 in. long, $1\frac{1}{2}$ in. broad. In Horsfield's specimens the leaves are $11\frac{1}{2}$ in. long, $2\frac{3}{4}$ in. broad, on petioles 8 lines long; the raceme is above a foot long, with flowers $\frac{3}{4}$ in. apart, on pedicels 1 line long; the calycine lobes are 4 lines long; the petals 8 lines long, 6 lines broad, agglutinated by their claws to the staminiferous tube. The analysis of the flower, and a drawing of the fruit in its natural size, are shown in Plate XIV. figs. 4–9.

The *Barringtonia racemosa* of Blume (non Juss.) is considered by Miquel to be the same as Horsfield's plant from Patjetan and Banca, which is here regarded as identical with Rumphius's plant from Amboyna, in the same region. Blume's species, *B. racemosa*, in Van Houtte's Flora, is a heterogeneous mixture of plants from all quarters.

There can therefore be no hesitation in placing under this species the Java plants enumerated by Blume and Miquel under the name of *B. racemosa*, that species being confined to the Indian peninsula and Ceylon.

5. Butonica rubra, nob.: *Butonica Tsjeria Saamstravadi*, Rheede, Hort. Malab. part iv. p. 15, tab. 7: *Eugenia acutangula*, Linn. (in parte), Sp. Pl. i. 471: *Stravadium rubrum*, DC. (in parte), Prodr. iii. 289: *Stravadia rubra*, Pers. (in parte), Ench. i. 30: *Barringtonia rubra*, Bl. in Van Houtte, Fl. Serr. vii. 23: arbor alta, ramulis pallide brunneis, lignosis, angulatis, rugulosis: foliis approximatis, ellipticis, apice in acumen acutum subito constrictis, infra medium spathulato-angustatis, circa petiolum repente rotundato-truncatis, obsolete et obtuse serratis, chartaceis, supra sæpe pallidissimis, albidule opacissimis, aut pallide viridibus, nervis patenti-divaricatis venisque transversim reticulatis vix prominulis, costa plana, tenuiter carinata, et imo subdilatata, subtus pallidis, opacis, costa striolata nervisque prominulis; petiolo latiusculo, supra plano, subtus convexo et striolato, limbo 20plo breviore: racemo terminali, longissimo, pendulo, remote plurifloro; floribus tenuiter pedicellatis; calycis limbo mediocri, globoso, demum in lobos 3–4 oblongos subcoriaceos parallele nervosos opace granulosos rupto; petalis 4, duplo vel triplo longioribus, oblongis, purpureis; staminibus, disco styloque ut in char. gen.; ovario infero, turbinato, 4-loculari, ovulis in quoque loculo 2 suspensis: fructu oblongo, utrinque rotundato, calyce coronato, sub-4-gono, angulis rotundatis, abortu 1-loculari et monospermo; pericarpio crassissimo; semine cylindrico. In penins. Indiæ: *v. s. in hb. Hook.* Quilon (*Wight* 1064), Concan (*Horter*); *in hb. Soc. Linn.* hort. Calc. cult. (Wall. Cat. 3634 c).

This is a second exclusively Indian species, sufficiently well described by Rheede, which has been strangely confounded with Rumphius's *B. terrestris* from Amboyna and Java, and also with *Stravadium acutangulum*, by all botanists. The mistake originated with Linnæus, who confounded Rumphius's plant with Hermann's, and was unacquainted with any of the plants mentioned by him as synonyms. It is, however, a well-marked species. Rheede describes it as a tall tree; but his drawing of a fruit-bearing branch, being reduced to half its due proportions, renders it difficult of recognition. It differs, however, from *B. terrestris* in its much shorter and much broader leaves; and its fruit, though somewhat similar, is longer and narrower. It differs from *B. racemosa* for the same reasons. It bears no resemblance whatever to *Stravadium acutangulum*. Its leaves, about $\frac{3}{4}$ in. apart, are $6\frac{1}{2}$–$8\frac{1}{2}$ in. long, $3\frac{1}{4}$–4 in. broad, on petioles 4–5 lines long; the slender raceme is 28–36 in. long; the slender pedicels, $\frac{1}{2}$ in. apart, are 3 lines long; the calycine limb is globular and entire in the bud, 5 lines in diameter, soon splitting into 3 equal lobes; the petals are 9 lines long; the outer series of filaments are 11 lines long, the inner series being gradually shorter. The fruit, as shown in Rheede's drawing, when restored to its proper size, would be $3\frac{1}{2}$ in. long, $1\frac{1}{2}$ in. broad, of an oblong shape, rounded at both ends, quadrately cylindrical, with obtuse angles, with a thick pericarp enclosing a cylindrical nucleus, said to be of a sweetish taste at first, but afterwards having an unpleasant bitter flavour. The fruit in its natural dimensions is shown in Plate XIV. fig. 2, the flower in fig. 1.

6. Butonica alata, nob.: *Barringtonia alata*, Wall. Cat. (non Miq.); Griffith, Notulæ, iv. p. 636; Icon. Pl. Asiat. tab. 636. figs. 1–6 (in errore sub *Barringtonia conoidea*):

fruticosa, ramulis brunneis, pallide glaucis, interrupte striatis, apice confertim foliosis; foliis oblongis, apice in acumen breve obtusum constrictis, basin versus angustatis et subito rotundiusculis, obsolete serratis, dentibus obtusissimis, chartaceis, supra profunde viridibus, opacis, nervis vix prominulis, subtus pallidioribus, opacis, costa nervis venisque reticulatis prominulis; petiolo latiusculo, limbo 40plo breviore: racemis axillaribus, subspicatim erectis, folio dimidio vel bis triente brevioribus, subpaucifloris; pedicellis tenuiter teretibus, imo articulatis et minute bibracteolatis; calycis limbo mediocri, primum globoso-ovato, apice mucronulato, demum in lobos 2, dein in 4, rupto; petalis 4, oblongo-lanceolatis, carnosulis, albide carneis; staminibus, disco styloque ut in char. gen.; ovario infero, conico-cylindrico, 6-sulcato, imo umbilicato et 6-lobo, 4-loculari, ovulis in quoque loculo 2 suspensis: drupa majuscula, conice elongata, imo profunde umbilicata, apice 6-sulcata et calyce coronata, basin versus in lobos 6 crasse alatos pendentes expansa, 1-loculari, abortu 1-sperma; pericarpio sicco, fibroso; semine majusculo, ovato, 6-sulcato, ab apice pendulo; embryone conformi, homogeneo, neorhiza interna conspicua. In Malacca: *v. s. in herb. Hook.* Mergui (*Griffith*); *in hb. Soc. Linn.* Moulmein (*Wall. Cat.* 3633); *v. fruct. in Mus. Soc. Linn.* (*Wallich*).

We have no published account or manuscript details of this remarkable species. Griffith's analysis of its fruits, which agrees with all I found in Wallich's specimen (as shown here in Plate XIV.), is figured in his work in plate 636 B, figs. 1 and 6, through the mistake of the editor of the 'Notulæ,' under the name of *Barringtonia conoidea*, while the fruit of the latter is not represented by him, though it is well described in a manuscript note attached by him to his specimen of the plant.

The leaves are 7–10 in. long, $2\frac{1}{2}$–$3\frac{1}{2}$ in. broad, on a rather wide flat petiole $1\frac{1}{2}$–2 lines long, and they have about 11 pairs of curving subascending nerves; the racemes are 3–4 in. long, with a slender, erect, compressed, striolated, brownish-opaque rachis, bearing alternate flowers $\frac{3}{4}$ in. apart; the slender subnutant pedicels are 9 lines long; the calycine lobes, after bursting, are $4\frac{1}{2}$ lines long, 2–3 lines broad, pruinosely opaque, concave; petals pruinose outside; the fruit, including the wings, which descend $\frac{3}{4}$ in. below the top of the pedicel, is $2\frac{1}{2}$ in. long, $\frac{5}{8}$ in. near the apex, gradually widening to a breadth of 2 in. across the six compressed subcoriaceous wings; pericarp $1\frac{1}{2}$ line thick, with an oval cell somewhat narrow at the apex, the axis and dissepiments being pressed together on one side; seed oblong, 6-sulcated, suspended by a funicle, around which the abortive ovules are seen; the hard homogeneous nucleus is $1\frac{1}{2}$ in. long, 1 in. in diameter, the internal neorhiza having a diameter of half that size, and is partially free from the exorhiza, showing a sensible interval between them. An analysis of Wallich's specimen of the fruit is shown in Plate XIV. figs. 13, 14.

7. Butonica inclyta, nob.: *Barringtonia racemosa*, Griffith (non Bl. nec alior.), Notulæ, p. 659; Icon. Pl. Asiat. tab. 636. 2 (non 1). fig. 1 ad 6: ramulis subtenuibus, apice, crebre foliosis: foliis mediocribus, obverse obovato-oblongis, apice valde obtusis aut rotundatis, sæpe emarginatis, infra medium subcuneatim angus-

tatis, circa petiolum subito anguste rotundiusculis, marginibus subintegris, valde revolutis et subretuse undulatis, subcoriaceis, supra pallide viridibus, valde opacis, ruguloso-granulatis, nervis adscendenti-divaricatis, semiimmersis, reticulatis, subtus rufescenti-pallidis, opacis, nervis venis costaque plana et striolata prominulis; petiolo brevissimo, aut vix ullo: racemo axillari; floribus ignotis: fructu majusculo, obpyriformi-oblongo, 8-sulcato, calyce coronato; pericarpio crassissimo, ligneo-fibroso, abortu 1-loculari et monospermo; semine magno, ab apice suspenso, 10-sulcato; testa subcoriacea, cum racheos ramis longitudinalibus in sulcos immersis; embryone conformi, mesopodo, apice in germinatione radicem pullulante, imo caulem novum emittente (sec. cl. Griffith). In Malacca: *v. pl. s. in hb. Hook.* (*Griffith*) sine flore.

A species well distinguished by the size and shape of its leaves, and by the larger size of its fruit, which is differently constructed from that of *Butonica racemosa*, to which Griffith referred it. He gives no description whatever of his plant, but he figures the fruit. In his 'Notulæ' he states that he found 4 species of *Barringtonia* in Malacca:— 1st, this plant, of which he sent home a specimen. 2nd, his *B. conoidea*, well represented separately in the plant, its inflorescence, and also in its fruit, in his plate 636, and which I have referred to *B. alata*. 3rd, *B. alata*, of which no account is given, but its fruit is well shown in his plate 635, and which his editor mistook for that of *B. conoidea*, confounding together Griffith's explanations of the two; both the fruit and specimens of the plant are manifestly identical with Wallich's plants of the same. 4th, *B. cylindrostachys*, which I have referred to the genus *Doxomma*. Its approximated leaves are 4½–6½ in. long, 2–2½ in. broad, on broadish petioles, 1½–2 lines long; a bare raceme is seen in the specimen, the rachis of which is 6 in. long, with cicatrices of the fallen flowers ½ in. apart. The fruit in Griffith's drawing is large, 3½ in. long, 2½ in. in diam., rounded at the base, tapering a little above the middle, and crowned by the persistent calyx; the fibrous pericarp is 6 lines thick; the suspended seed as large as a fowl's egg, showing at its summit the abortive ovules, and the axis and abortive dissepiments pressed to one side, appearing like a thick longitudinal raphe; but the true raphe is seen in ten longitudinal branches imbedded in the thickish testa, which are opposite to as many furrows in the large embryo. This is drawn in its full size, showing the commencement of its germination by the protrusion of a small nipple in the summit, which afterwards expands into a root, while the bottom of the exorhiza splits to allow the exit of the extremity of the neorhiza, afterwards becoming the new stem, charged with scales; and upon this structure and on the mode of its germination, Griffith offers the remarks to which I have before alluded (p. 50). The fruit of this species is shown in Plate XIV. fig. 19.).

8. Butonica rosata, nob.: *Menichea rosata*, Sonnerat, Voy. Guin. (1776), p. 133, tab. 92, 93: arbor ramis crassis: foliis oblongo-lanceolatis, apice sensim acute acuminatis, imo longe cuneatis, obsolete serrulatis, petiolo brevi: racemis terminalibus vel e trunco enatis, nutantibus, folio subæquilongis; floribus alternis, pedicellatis; calyce demum in lobos 3 acutos rupto; petalis 4, albis, concavis, apice rotundatis; staminibus, disco styloque ut in char. gen.; ovario infero, turbinato, acute 4-gono, 4-locu-

lari: fructu oblongo-ovato, utrinque angustiore, 4-gono, obtuse angulato, breviter stipitato, calyce coronato; pericarpio roseo, carnosulo, abortu monospermo; semine ovali, apice acutiore, funiculo brevi sub apicem suspenso; testa parallele plurinervoso; embryone valde oleaginoso, eduli. In insulis Philippinis et Formosa: *v. pl. sic. in hb. Mus. Brit.* Formosa (*Oldham* 115).

This is described by Sonnerat as a tree growing in moist places at Sambouangue and elsewhere. Oldham's specimen from the adjoining island of Formosa agrees well with Sonnerat's drawing in plate 92, where the plant is represented in one third of its natural size, judging from the comparative dimensions of the calyx there shown—and in his plate 93, where it and the fruit are drawn in their proper dimensions. The leaves in Oldham's plant agree in shape and size with those of Sonnerat, restored to their full size: these are $8\frac{1}{2}$–9 in. long, $2\frac{3}{4}$–3 in. broad, on shortish petioles. The raceme, restored to its due size, is 9 inches long, bearing about 12 alternate flowers, on slender pedicels 6 lines long; the lobes of the calyx are 4 lines long, $2\frac{1}{2}$ lines broad. The fruit, shortly stipitate, is $3\frac{1}{4}$ in. long, 2 in. in diameter, with a rose-coloured subfleshy pericarp; its single seed is $2\frac{1}{8}$ in. long, $1\frac{1}{4}$ in. broad; according to Sonnerat, it is very oleaginous and edible, forming one of the best fruits of the island, where it is called *Jam rosata*. The fruit is shown in Plate XIV. fig. 17.

9. Butonica intermedia, nob.: *Barringtonia intermedia*, Vieillard, Bull. Soc. Linn. Normand. vol. x. p. 4: *Barringtonia racemosa*, Seem. (non Bl.), Flor. Viti. p. 683: *Eugenia racemosa*, Forst. (non Linn. nec DeCand.), Prodr. Fl. Austr. 39; Vieillard *l. c.* p. 9: arbuscula: foliis summo ramulorum dense confertis, lanceolato-oblongis, apice acutis, infra medium spathulato-angustatis, ad basin arctatam truncato-rotundatis, margine grosse crenatis vel obtuse serratis, conduplicatis, glabris, supra pallide viridibus, nervis subpatentibus paullo prominulis intra marginem arcuatim nexis, costa tenui, deorsum sensim incrassata, subtus pallidioribus, nervis cum aliis intermediis brevibus venisque valde reticulatis prominentibus, costa valida in petiolum brevissimum latum desinente: racemo terminali, pendulo, folio 3–4plo longiore; rachi subtenui, angulata, striata, pruinosa, basin versus bracteolata, mox sparse florifera; floribus mediocribus; pedicellis tenuibus, 4-gonis, nutantibus, imo bracteola lineari-lanceolata caducissima munitis; calycis limbo primum globoso, mucronato, integre clauso, demum in lobos 3–4 inæqualiter rupto; petalis 4, crassiusculis, albido-violaceis; staminibus numerosissimis, imo monadelphis, interioribus sæpe anantheris; ovario infero, turbinato, 4-gono, 4-loculari, ovulis in quoque loculo 4, pendulis: fructu oblongo, utrinque subalatim 4-angulato; pericarpio coriaceo, subtenui. In insulis Neo-Caledonia et Vitiensibus: *v. s. in hb. Hook.* Wagap (*Vieillard* 2239), Kanalak (*De Planche* 86, 87); *in hb. Mus. Brit.* New Caledonia (*Forster* sub *Eugenia racemosa*), New Caled. (*Anderson* sub *E. racemosa*), Fiji ins. Taviuni (*Seemann* 149).

A tree 10–20 feet high, according to Vieillard, found in maritime places or in running streams on the sea-coast (*Seemann*). The leaves in all the above specimens resemble each other in their shape and venation, varying from 10 to 15 in. long, $2\frac{7}{8}$–$3\frac{1}{4}$ in. broad, on

petioles 1–2 lines long; the racemes, in the specimens, are 10–19 in. long; but Vieillard says they are often found $2\frac{1}{2}$ to 3 feet in length: he also states they are sericeous; but in his specimen, as well as in all the others, they are glabrous and pruinosely opaque; the slender pedicels, $\frac{3}{4}$ in. apart, are generally $\frac{3}{4}$–1 in. long, shorter in the younger flowers; the globose calycine limb is $4\frac{1}{2}$ lines in diameter, and splits into 3 lobes 5 lines long; the petals are 1 in. long, 6 lines broad, with the lateral margins retroflected; the ovary is $2\frac{1}{2}$ lines long, with 4 almost winged angles. Seemann's specimen of the fruit, apparently not ripe, accords with the description of Vieillard; it is oblong, acute at base, narrowed above, 2 in. long, $\frac{3}{4}$ in. broad, crowned by calycine lobes, narrowly winged on its angles, and contains a single suspended seed with a mesopodal embryo. This fruit, according to Seemann, is poisonous, and used for stupifying fishes; it is called Vutu-ui-wai (Water-vutu).

10. Butonica procera, nob.: *Barringtonia excelsa*, Benth. (non Bl.), Lond. Journ. Bot. ii. 221: arbor elata, ramulis in summo crebre foliosis: foliis majusculis, elongato-oblongis, apice breviter aut sensim acuminatis, infra medium spathulato-angustatis, imo obtusis vel rotundato-truncatis, marginibus revolutis, sub medium integris, superne crenato-serratis, chartaceis, supra pallide viridibus, opacis, nervis conspicuis divaricatis intra marginem nexis, costa supra plana, versus imum sensim incrassata, subtus pallidioribus; petiolo vix ullo: racemo subterminali solitario (vel interdum 3 subaxillaribus congestim approximatis); rachi longissima, pendula, folio triplo longiore, glabra, acute angulata, striata; floribus inferioribus sparsis, superioribus crebrioribus; pedicellis brevissimis, crassis, ebracteatis, floribus hinc subsessilibus; calycis limbo primum globoso, integre clauso, dein in lobos 2 apice sæpe bifidos coriaceos concavos pruinosos extus granulatos rupto; petalis 4, triplo longioribus, oblongo-ovatis, albis, membranaceis, lateribus subretroflexis, unguibus tubo staminifero agglutinatis; staminibus, disco styloque ut in char. gen.; ovario infero, cylindrico, medio ventricoso, 8-costato, cinereo-pruinoso, 4-loculari, ovulis in quoque loculo 4 per paria axi pendulis: fructo ignoto. In insulis maris Pacifici: *v. s. in herb. Hook.* New Hebrides, in Tanna (*Hinds*); *in hb. Mus. Brit.* Tanna (*Hinds*).

A very peculiar species, referred by Mr. Bentham to *Barringtonia excelsa*, Bl., which is a very different plant. Hinds states that it is a large, lofty, handsome tree; it must not be confounded with specimens collected by Barclay at the same time in the same island, which I have referred to *B. samoënsis*. Its leaves are 12–18 in. long, $3\frac{1}{4}$–$5\frac{1}{4}$ in. broad, on petioles scarcely appreciable in length, being a short extension of the costa, 2 lines broad; the raceme is single, and nearly terminal in Hinds's specimen; but he remarks, in a note, that he had seen three of these spicated racemes forming only a part of a very magnificent cluster of flowers; the rachis in the specimen is as long as the leaves, somewhat slender, bearing many spicated flowers, almost sessile, the lower ones $1\frac{1}{2}$ in. apart, gradually closer upwards; the calycine lobes are 4 lines long; the petals 12 lines long, 5 lines broad; the outer series of stamens somewhat exceed the length of the petals; the circular disk supports on its outer margin the staminiferous tube; and its

inner margin rises in a short membranaceous erect tube, leaving a deep hollow, radiately striated, between it and the style.

11. Butonica samoënsis, nob.: *Barringtonia samoënsis*, A. Gray, Un.-St. Expl. Exped. p. 508; Walpers, Ann. iv. 852: *Barringtonia excelsa*, Gray (non. Bl. nec Benth.) *loc. cit.* p. 508: *Barringtonia racemosa*, Gaud. (non Bl.), Freyc. Voy. p. 483, tab. 107 (excl. syn.): *Stravadium insigne*, Bl. in Van Houtte, Flor. Serr. vii. p. 24, tab. 654, 655: *Barringtonia insignis*, Miq. in Flor. Ned. Ind. i. p. 488: *Barringtonia acutangula*, Bl. (non Roxb.), Bijdr. 1097, sec. Miq. *loc. cit.*: arbor, ramulis subcrassis, striatis: foliis subapproximatis, lanceolato- vel obovato-oblongis, apice acute attenuatis, imo sensim angustioribus et subobtusis, marginibus vix revolutis crenato-undulatis, subserratis, flaccidis, submembranaceis, supra viridibus, opacis, ad nervos sulcatis, nervis tenuibus adscendentibus venisque rubellis reticulatis paullo prominulis, subtus pallidioribus, opacis, minute granulatis, costa nervisque prominulis; petiolo semitereti, latiusculo, limbo 33plo breviore: racemo terminali, pendulo; rachi gracili, elongata; floribus speciosis, alternis, breviter pedicellatis; calycis limbo mediocri, primum integre globoso, demum in lobos 3–4 rupto; petalis 4, triplo longioribus, obtuse oblongis, subcrassis, marginibus membranaceis undulato-subrecurvatis; staminibus, disco styloque ut in char. gen.; ovario infero, turbinato, 4-gono, 4-loculari, ovulis in quoque loculo 4, suspensis: fructu longiuscule oblongo, utrinque acutiore, lobis calycinis coronato, 4-gono, angulis costatis, abortu 1-loculari et monospermo, semine suspenso, embryone mesopodo. In insulis Oceani Pacifici: *v. s. in hb. Hook.* Port Resolution, Tanna (*Barclay* 3487); *in hb. Mus. Brit.* Tanna (*Barclay*).

A species hitherto found only in the New Hebrides, Navigators', and the Ladrone or Mariana group of islands. It is said to be a tall handsome tree, growing in moist places; it is well represented in Gaudichaud's drawing, the leaves of which approach those of Dr. Gray's var. β. The plant is everywhere glabrous; the leaves are 8–15 in. (sometimes 24 in.) long, $2\frac{1}{2}$–$3\frac{1}{2}$ in. broad (in var. β $4\frac{1}{2}$ in. broad), on petioles 3 lines long and $1\frac{1}{2}$ line broad, with about 18 pairs of subascending nerves, with others shorter and intermediate, all anastomosing; the terminal raceme is 15–24 in. long, with a rather slender rachis, bearing alternate flowers $\frac{3}{4}$ in. apart, which, when expanded, are 2 in. across; pedicels 2–4 lines long; calycine limb at first globose, 3 lin. in diam., splits into 3–4 lobes; petals 10 lin. long, 5 lin. broad; the fruit, as shown in Gaudichaud's drawing, is 3 in. long, $1\frac{7}{8}$ in. broad, with 4 costate angles, decurrent on the pedicel. Gaudichaud's description of the seed is, that it is rostellated and bilobed at the apex. This would be better interpreted by saying that, as in all the other species, the seed is suspended by a funicle, to which the abortive ovules are also attached, and which seems lobed at its apex, as Griffith shows in his Icones, pl. 635. fig. 3. Van Houtte's drawing, tab. 654, to which he gave the name of *Stravadium insigne*, Bl., does not appear to have been made from any cultivated specimen, as he would lead us to suppose; its originality may indeed be doubted, after what I have shown in regard to his drawing, tab. 409, under *Barring-*

tonia speciosa. From the resemblance of the former, in the form and size of the leaf and the size of the flowers, we may infer that it is a made-up drawing, with its details borrowed from that of Gaudichaud. The analysis of the flower and the fruit are shown in Plate XIV. figs. 20–25.

12. Butonica edulis, nob.: *Barringtonia edulis*, Seem. Fl. Vit. p. 82: arborea: foliis elliptico-oblongis, apice sensim acutis, infra medium cuneatim angustatis, imo rotunde truncatis, marginibus cartilagineis subserratis cum punctis nigris in sinibus, flaccide chartaceis, supra pallide viridibus, nervis divaricatis fere recte adscendentibus paullo prominulis, venis tenuiter reticulatis, subtus subconcoloribus, nervis prominentibus, costa tenui striolata; petiolo late planato, brevissimo: racemis elongatis, pendulis, cinereo-tomentosis; rachi subangulata; floribus sparsis pedicellatis; calycis limbo primum globoso, clauso, apice mucronulato, cinereo-tomentoso, demum in lobos 3 vel 4 convexe rotundos longitudinaliter nervosos rupto; petalis 4, oblongis, utrinque attenuatis, glabris, albis; staminibus petalis longioribus; disco styloque ut in char. gen.; ovario infero, turbinato, 4-loculari, ovulis plurimis ab axi superne funiculis suspensis: fructu elongato-oblongo, utrinque obtuso, ambitu rotundo (nec 4-gono), eduli. In insulis Oceani Pacifici: *v. s. in hb. Mus. Brit. et Hook.* Fiji, Vutu-kana (*Seemann* 150), Viti (*Seemann*); *v. fr. in Museo Kew.* (*Seemann*).

A species near *B. intermedia*, differing in its broader leaves, with dissimilar nerves, its tomentose raceme with larger flowers. It is a tree 30–40 feet high, of erect growth; its leaves are 9–14 inches long, $3\frac{1}{4}$–5 in. broad, on petioles 1–2 lines long and broad; the raceme is about 10 in. long; rachis 1 line thick; flowers $\frac{1}{4}$–$\frac{1}{2}$ in. apart; pedicels 2 lines long; calycine limb in bud 4 lines in diameter; petals $1\frac{1}{4}$ in. long, 5 lines broad; stamens $1\frac{1}{2}$ in. long: the fruit in Seemann's specimen is $2\frac{3}{4}$ in. long, $1\frac{1}{2}$ in broad, crowned by the persistent calyx, and distinctly rounded, not acutely 4-gonous, as in the two other species growing in the island; the largest he saw, in a more mature state, was 4 in. long, $1\frac{1}{2}$ in. across. The seed is eaten by the natives either when cooked or in the raw state, while in the other species it is poisonous. Seemann wrongly describes the calyx to consist of 4 rounded sepals, and did not notice that it is at first globose and entire, afterwards splitting into 3 or 4 lobes. It is called *vutu-kana* or *vutu-kata*.

13. Butonica calyptrata, R. Br. MSS., in Benth. Austr. p. 287: ramulis crassis, cortice rimoso, e foliis lapsis cicatricibus majusculis creberrimis signatis: foliis superioribus mediocribus, reflexis, elongato-oblongis, apice ovatis aut rotundato-obtusis, imo sensim angustioribus, late acutis, marginibus tenuibus plicato-undulatis vix crenulatis, flaccide chartaceis, supra luride viridibus, in areolis glauco-opacis, nervis tenuibus rufulis prominulis reticulatis, subtus ferrugineo-pallidioribus, opacis, costa striolata nervisque paullo prominentibus; petiolo compresso, limbo 24plo breviore: racemo vix terminali; rachi crassiuscula, angulata, striata; floribus brevissime pedicellatis; calycis limbo primum globoso et integre clauso, rugose costatim nervoso, in lobos 2, dein in 4 rupto; petalis subparvis oblongis; stamini-

bus numerosis, imo breviter monadelphis; disco styloque ut in char. gen.; ovario infero, turbinato, 4-loculari, ovulis pluribus axi suspensis. In Australia: *v. s. in hb. Mus. Brit.* Lizard Island, New South Wales (*Banks and Solander*).

A very distinct species. Branchlets $\frac{1}{4}$–$\frac{3}{8}$ thick, singularly marked with crowded cicatrices of the fallen leaves; leaves 5–7 in. long, 2–2$\frac{3}{4}$ in. broad, on petioles 2$\frac{1}{2}$–3$\frac{1}{2}$ lines long; rachis of spike more than 8 in. long; flowers about $\frac{3}{8}$ in. apart; pedicels $\frac{1}{2}$ line long; calyx in bud globose, 4 lines in diameter, lobes very thin and brittle, obtusely oblong, little longer than ovary; stamens very numerous, not very long, all antheriferous.

14. Butonica ceylanica, nob.: *Barringtonia ceylanica*, Gardn.: *Barringtonia racemosa*, Thwaites (non Linn. nec Roxb.), Enum. 119 (excl. syn. et icon. Wight): *Stravadium obtusangulum*, Bl. in Van Houtte, Fl. Serr. vii. p. 24: ramis crassis, pallide brunneis, vel cinereis: foliis in ramulis brevibus congestis, oblongis, apice sensim acutis aut in acumen breve subito constrictis, imo cuneatis, crenato-serratis, dentibus sæpe aciculatis, curvatim subplicatis, flaccide chartaceis, supra fusco-viridibus, opacis, nervis tenuibus remotiusculis divaricatis et valde arcuatim nexis, venisque transversis reticulatis prominulis, subtus flavide pallidioribus, nervis rufis venisque prominentibus; petiolo subplano, fusco, limbo 24plo breviore: racemis terminalibus, mox pendulis, folio 2–3plo longioribus; rachi tetragona, angulis rugosis, alternatim spicatiflora; pedicellis fuscis, tenuibus, calyce longioribus; calycis limbo ovali-globoso, integre clauso, demum in lobos 3 rotundatos rupto; petalis 4, triplo longioribus, oblongis, lateribus revolutis; staminibus, disco styloque ut in char. gen.; ovario infero, turbinato, tetragono, 4-loculari, ovulis in quoque loculo 2, suspensis: drupa immatura elongato-oblonga, utrinque subacuta, calyce coronata, abortu 1-loculari et 1-sperma. In Indiæ penins. et Ceylon: *v. s. in hb. Hook. et Mus. Brit.* Ceylon (*Thwaites* 2682); *in hb. Hook.* Indiæ penins. (*Rottler*).

This species, peculiar to Southern India and Ceylon, grows in moist situations at an altitude of 1500 feet. Its leaves are 6–8 in. long, 2$\frac{3}{4}$–3 in. broad, always acute at base, upon a broad stout petiole 3–4 lines long, and with about 15 pairs of nerves; slender raceme 12–15 in. long; slight angular pedicels about $\frac{1}{4}$–$\frac{1}{2}$ in. apart and 5–7 lines long; calyx in bud 3–4 lines long; petals 8–9 lines long, 5 lines broad, internal margin of disk more urceolate. The species is distinguishable from *Butonica racemosa* (to which it has been referred) by its smaller, more elliptic, less acuminated leaves, longer petioles, flowers smaller, on comparatively longer pedicels, an elongated fruit acute at both extremities: it is nearer *Butonica intermedia*. Mr. Thwaites makes two varieties of this species, principally because in the one the calyx is quite closed, and in the other slightly open at the apex. This appears to arise from the different ages of the raceme. In the younger buds the calyx is of course quite closed; in the more advanced stage the limb begins to open in the apex, and the pedicel lengthens. The thickish limb of the calyx splits irregularly nearly to the base into 3 or 4 lobes. The fruit, in section, is seen in one of Mr. Thwaites's specimens; it appears quite smooth, obtusely oblong, 1$\frac{3}{4}$ in. long, $\frac{1}{2}$ in.

broad, with a pericarp 1 line thick, very different in size and shape from that of *B. racemosa.*

15. Butonica caffra, nob.: *Barringtonia caffra,* E. Mey. MSS.: *Barringtonia racemosa,* Oliv. (non Bl.) in Flor. Afr. ii. 438: ramulis crassiusculis, striolatis, fistulosis: foliis late vel elliptico-oblongis, apice sensim aut breviter acuminatis, infra medium gradatim angustioribus subcuneatis, marginibus cartilagineis subrevolutis, aut integris et crenulatis, vel punctis callosis obsolete dentatis, chartaceis, supra læte viridibus, nervis tenuibus patentim divaricatis et arcuatim nexis, subtus pallidioribus, costa valida, deorsum sensim incrassata, nervis venisque reticulatis prominentibus; petiolo semitereti, latiusculo, brevi: racemo terminali, longiusculo, pendulo; rachi subtenui angulata, striata; floribus spicatis, speciosis, subsparsis, pedicellis brevibus; calycis limbo primum globoso et integre clauso, demum in lobos sæpius 4 rupto; petalis 4, duplo vel triplo longioribus, oblongo-ovatis; staminibus, disco styloque ut in char. gen.; ovario infero, turbinato, subtetragono, ruguloso, 4-loculari, ovulis in quoque loculo 2 suspensis: fructu ovato-oblongo, lobis calycinis immutatis coronato, obsolete tetragono. In Africa australi: *v. s. in hb. Hook.* fluv. Zambesi (*Miller*), fluv. Rovuma (*Miller*), fl. Luaba (*Kirk*), Zanguebar (*Kirk* 78), S. Africa (*Drège*); *v. fruct.* in Mus. Kew. (*Kirk* 78).

A large tree, according to Miller, who found it growing along the banks of the Rovuma over an extent of twenty miles. It is very distinct from the Indian species *B. racemosa.* The branches are closely covered at the extremities by large leaves, which soon fall off and leave large cicatrices at the points of their insertion 3 lines apart; the leaves are 8–17 in. long, $2\frac{3}{4}$–$4\frac{1}{2}$ in. broad, on petioles seldom more than 1 line long and broad, and have about 18 pairs of rather straight divaricating nerves; the raceme is 18–30 in. long, the pedicels about $\frac{1}{2}$ in. apart and 2–3 lines long; the calycine limb is globular and entire in the bud, is 3–4 lines in diameter, the petals about 9 lines long. The fruit collected by Dr. Kirk is oval, slightly narrowing at each extremity, obsoletely 4-angled, crowned by the unchanged calycine lobes, is 2 in. long, $1\frac{1}{4}$ in. broad, and contains a single seed, as in other species of this genus. The leaves in Drège's specimen are longer and broader than in the others, and probably may be regarded as a variety.

16. Butonica apiculata, nob.: ramulis crassiusculis, rugosis, striatis, summo crebre foliosis: foliis oblongis, apice in acumen breve acutum subito constrictis, imo cuneatis, obtuse et breviter serratis, chartaceis, supra viridibus, nervis tenuibus utrinque circiter 10 cum aliis brevioribus interjectis, prominulis, costa tenui, subtus paullo pallidioribus, subopacis, costa prominente; petiolo limbo 15–20plo breviore: racemo terminali, brevi; rachi angulata, compressa, striata, opaca; floribus approximatis, breviter pedicellatis; calyce globoso, integro, demum in lobos 4 rupto; ovario infero, 4-loculari, ovulis 2 in quoque loculo suspensis: fructu immaturo oblongo, 4-angulari, utrinque subacuto, lobis calycinis 4 coronato. In Madagascar: *v. s. in hb. Hook.* loc. cit. (*Pervillé*).

A species collected by Capt. Pervillé in Madagascar. It is distinguished from the

preceding by its smaller leaves sharply spiculated, with fewer nerves and a longer petiole, a much shorter and stouter raceme. Its leaves are 5–6 in. long, $2\frac{1}{4}$–$2\frac{3}{4}$ in. broad, on a petiole 3–5 lines long; the rachis of the raceme is 13 in. long, and bears alternate flowers $\frac{3}{4}$–1 in. apart, on pedicels 2 lines long. The flowers had all fallen away, leaving some half-grown ovaries or immature fruits 7 lines long, crowned by 4 calycine lobes 3 lines long.

4. Stravadium.

This genus is maintained by very efficient and unmistakable characters. It was established by Jussieu in 1709 [1] upon the *Tsjeria Saamstravadi* of Rheede [2] and a few other species. It was acknowledged by Blume [3] and DeCandolle [4], but rejected by Roxburgh and other botanists, who conjoined it with a group of species under a genus called *Barringtonia*, very different from the true *Barringtonia* of Forster; and hence have arisen the many complications that followed. Miquel attempted a monograph of the family [5], which has created still further confusion among the species. He enumerated under *Barringtonia* 17 species [6], apportioning them into 2 sections, *Butonica* and *Stravadium*, after the example of Endlicher [7], by characters so loose that he quite disregarded them in the arrangement of his species, and he thus rejected *Stravadium* as a genus. Blume at a later period still acknowledged *Stravadium* [8], enumerating 11 species, the first 6 of which only can be retained. The authors of the 'Genera Plantarum' adopted entirely [9] the views of Miquel.

We must attribute all these discrepancies to the entire disregard shown by most authors to the structure of the free portion of the calyx. The difference is well marked in several cases, where this free portion is vesicular and entire in the bud, but is soon ruptured by the pressure of the petals into 2, 3, or 4 lobes, which are either very large or moderately small—characters constant in the genera *Barringtonia*, *Agasta*, and *Butonica*; on the other hand, in *Stravadium* this calycine border is divided, even in the bud, into 4 small rounded ciliolated sepals, somewhat imbricated in æstivation, as in *Carya* and *Planchonia*. It is easy, therefore, without the possibility of mistake, to detect at once any species of *Stravadium*, a genus distinguished by the presence of 4 free sepals in the calycine border, an ovary constantly 2-celled, with 2 suspended ovules in each cell, producing an oblong, subtetragonous, indehiscent fruit, which by abortion is 1-celled, with a single large seed that fills the cell, and that consists of an exalbuminous embryo, like that already described in *Butonica*.

We may regard the *Eugenia acutangula* of Linnæus as the type of the genus, with which many other different species have been confounded by botanists under the name of *Barringtonia acutangula*.

[1] Gen. p. 326.
[2] Hort. Malab. iv. p. 15, tab. 7.
[3] Bydr. 1097.
[4] Prodr. 3239.
[5] Fl. Ned. Ind. i. 485.
[6] Van Houtte, Fl. Serr. vii. p. 23.
[7] Gen. Pl. p. 1233. no. 6325.
[8] Van Houtte, Fl. Serr. vii. p. 23.
[9] Gen. Pl. i. 720.

STRAVADIUM, Jussieu.

Stravadia, Pers.; *Meteorus*, Lour.; *Butonica* (in parte), Rumph.; *Barringtonia* (in parte), Miquel et alior.; *Botryoropis*, Presl.

Calycis adnati *limbus* 4-sepalus: *sepala* parva, rotundata, membranacea, sæpius ciliata, æstivatione subimbricata, persistentia. *Petala* 4, oblonga, 3–4plo longiora, unguibus tubo staminigero affixa et cum illo caduca. *Stamina* numerosissima, multiseriata, imo breviter in tubum erectum monadelpha: *filamenta* filiformia, petala vix excedentia, æqualia, omnia antherifera. *Stylus* tenuiter subulatus, paullo incurvus, eorum longitudine: *stigma* parvum, clavatum: *ovarium* inferum, turbinatum, sæpius 4-angulatum, semper 2-loculare, vertice intra discum valde concavum; *ovula* in quoque loculo 2, ab apice funiculo brevi suspensa. *Fructus* oblongus, plus minusve elongatus, tetragonus, angulis sæpius costatis, calyce coronatus, abortione 1-locularis et monospermus: *pericarpium* subcrassum, coriaceum, fibrosum: *semen* loculum implens, apice suspensum, homogeneum, structura ei *Butonicæ* simile.

Arbores *in India orientali, Malacca, Archipelago Asiat. et Australia vigentes, sæpius mediocres:* folia *oblonga, utrinque acuta, serrata, petiolata:* racemi *terminales, longe spicati:* flores *subparvi.*

1. STRAVADIUM ACUTANGULUM, nob.: *Eugenia acutangula*, Linn. Sp. Pl. i. 673 (excl. syn.); Syst. Veg. i. 461; Flor. Zeyl. p. 85. no. 190 (excl. synon. in Pl. Hermann. iv. p. 50); Willd. Sp. ii. 966 (excl. syn.): *Barringtonia acutangula*, Gaertn. Fruct. ii. 97, tab. 101; Roxb. Fl. Ind. ii. 635 (exclus. syn. Lour. et Rumph.); Thwaites, Enum. p. 118 (in parte): foliis in apice ramulorum congestis, oblongis, apice obtusis aut subacutis, infra medium sensim cuneatis, chartaceis, margine crenato-serrulatis, dentibus obtusis sæpe aciculato-mucronatis, glabris, supra viridibus, minute granulosis, nervis tenuissimis venisque reticulatis semiimmersis, subtus cinereo-glaucis, opacis, nervis venisque prominulis; petiolo semitereti, supra plano, subtus corruguloso, limbo 10plo breviore: racemo terminali, spicato, mox pendulo, folio 6plo longiore; floribus parvis, subsparsis, brevissime pedicellatis, glabris; sepalis 4 (rarissime 3), ovatis, erectis, marginibus membranaceis acute serrulatis; petalis 4, obovatis, 3plo longioribus, membranaceis; ovario infero, turbinato, acute 4-angulari, 2-loculari: fructu (sec. Gaertn.) oblongo-ellipsoideo, tetragono, angulis crasse costatis, utrinque attenuato, calyce coronato, 1-loculari et monospermo, semine ut in char. gen. et 4-partibili. In Ceylonia: *v. s. in hb. Mus. Brit.; in hb. Hermanni, loc. cit. specimen typicum Linnæi*, Ceylon (*Thwaites* 1572).

In the typical specimen the leaves are $1\frac{1}{2}$–$2\frac{1}{2}$ in. long, $\frac{3}{4}$–$1\frac{1}{4}$ in. broad, on petioles 2–3 lines long; raceme 13 in. long; pedicels 1 line long; sepals $\frac{3}{4}$ line, petals $2\frac{1}{2}$ lines long.

Gaertner's figure of the fruit is from a specimen in the Leyden Museum, which came from Ceylon under the vernacular name *Medella*, the same as mentioned by Thwaites, and was probably contributed by Hermann to the Leyden collection, as he published there his work on the Ceylon flora. It is $1\frac{3}{4}$ in. long, $\frac{3}{4}$ in. broad across the prominent angles; the seed is oblong, subtetragonous, rounded at base, subacute at the apex, 13 lines long, 6 lines broad, the external portion (exorhiza) splitting into 4 parts along the sides. The plant in Ceylon bears the vernacular name of *Ella-medella-gass.*

Drawings of the typical plant, its flower, fruit, and seed, are shown in Plate XVII. figs. 1–14.

2. Stravadium obtusangulum, Blume, in V. Houtte, Fl. Serr. vii. p. 24 (excl. syn.): *Barringtonia obtusangula*, Miq. Flor. Ned. Ind. i. 491: *Barringtonia acutangula*, Thwaites (non Gaertn.) (in parte), Enum. p. 119: ramulis brunneis, remote lenticellatis: foliis oblongo-ellipticis, apice obtusis, raro vix acutioribus, imo sensim cuneatis, retuse serratis, dentibus obtusis, subrigide chartaceis, supra fusco-viridibus, costa tenui, nervis subadscendentibus venisque granulatis valde reticulatis prominentibus, subtus ferrugineo-opacis, costa nervisque prominentibus; petiolo fusco, sulcato, late marginato, limbo 12plo breviore: racemo terminali, spicato, folio longiore; rachi tenui, subflexuosa, angulata, glauco-pruinosa; floribus subparvis, subapproximatis, pedicellatis; sepalis 4, rotundatis, carnosis, margine membranaceo minute denticulatis; petalis 4, oblongis; ovario infero, turbinato, acute 4-angulato, ruguloso, fusco: fructu (sec. Bl.) elongato-ellipsoideo, utrinque subattenuato, obtuse tetragono, angulis incrassatis. In Ceylonia: *v. s. in hb. Mus. Brit.* Thwaites, 1592: *fruct. non vidi.*

This species differs from the preceding in its longer, broader, more obversely elliptic, much darker, more glabrous leaves, of very different aspect. They are 3–5 in. long, 1½–2 in. broad, on petioles 3–4 lines long; its raceme is 3–10 in. long; flowers 2–3 lines apart, sometimes more aggregated, upon pedicels 1–2 lines long; sepals ½ line long; petals 2 lines long. Thwaites's specimen agrees well with Blume's description, drawn from a Ceylon plant collected by Royer. Miquel states in a haphazard way that it is identical with the *Planchonia valida* of Blume, which, according to the former, is merely a form of *Planchonia sundiaca*. This cannot be admitted; but it offers another proof of the continual contradictions between Miquel and Blume which serve to mislead us.

3. Stravadium demissum, nob.: arbor demissa; ramulis tenuibus, pallide brunneis, striatis, apice confertim foliiferis: foliis elliptico-oblongis, sæpe subplicatim recurvulis, apice obtusatim acutis, imo sensim cuneatis, margine cartilagineo vix reflexo leviter sinuato-serratis, dentibus obtusis intus mucronulatis, firme chartaceis, supra opace viridibus, sub lente minutissime granulosis, nervis remotiusculis subadscendentibus semiimmersis reticulatis, costa tenui, subtus pallidis, opacis, sæpe dealbatis, costa, nervis venisque albescentibus et prominulis; petiolo semitereti, marginato, imo sæpe crassiore, limbo 12plo breviore: racemo terminali, sæpe longissimo, pendulo; rachi tenuissima, fusca, striolata, spicatiflora; floribus pro genere majoribus, sparsis, pedicellis bractea longiore refracta cuneato-lanceolata acute denticulata membranacea glabra munitis; sepalis 4, rotundato-ovatis, fuscis, sparse puberulis, marginibus membranaceis, ciliolatis; petalis 4, quintuplo longioribus, oblongo-obovatis, membranaceis, carneo vel pallide rubellis, extus subpruinosis, unguibus tubo staminigero extus adglutinatis; ovario infero, turbinato, acute tetragono, 2-loculari, ovulis in quoque loculo 2, apice suspensis: fructu immaturo oblongo, imo obtuso, apice calyce coronato, acute quadrato, angulis subcrenatis, abortu 1-loculari et monospermo. In Malacca et in insulis Malayensibus: *v. s. in herb. Hook.* Assam (*Masters* 363), Tenasserim et Andaman (*Helfors* 2422–2425) Malacca (*Griffith*), Malay penins. (*Griffith* 74), hort. cult. Calc. (*Griffith* 2425),

Mergui (*Griffith*); *in herb. Soc. Linn.* Amherst (*Wall. Cat.* 3635 C); Guayalpoor (*Wall. Cat.* 3635 A), Chittagong (*Wall. Cat.* 3635 D).

This species is said by Griffith to be a low tree, growing in moist woods, over all the Malayan provinces. Its branches are slender, with leaves crowded at their extremities, with axils 2–3 lines apart. The leaves are $3\frac{1}{2}$–5 in. long, $1\frac{1}{2}$–2 in. broad, on petioles 3–5 lines long; the raceme is 12–18 in. long, on a rachis $\frac{1}{4}$–$\frac{1}{2}$ line thick, with flowers 4–5 lines apart, on slender pedicels $1\frac{1}{2}$ line long, supported by a linear persistent bract 2 lines long; the sepals are 1 line long and broad, petals 5 lines long. The immature fruit, in Griffith's specimen, is $1\frac{1}{4}$ in. long, 8 lines broad, has 4 acute almost winged angles.

The species offers much resemblance to *S. Rheedii*, but differs in being of low stature, producing longer spicated racemes, which bear larger flowers on pedicels bracteated at their base, and in its fruit with almost winged crenulated angles.

4. STRAVADIUM RHEEDII, Blume in Van Houtte, Flor. Serr. vii. p. 24 (excl. synon.): *Barringtonia acutangula*, Roxb. (non Gaertn.) in parte, Fl. Ind. iii. p. 635 (excl. syn.); W. & A. Prodr. Fl. Ind. p. 335 (excl. syn.): *Eugenia racemosa*, Roxb. (non Linn.), Icon. E. I. C. Mus. tab. 149: arbor valida, ramosa, ramulis tenuibus, valde rugosis, pallide brunneis, striatis, cortice crasso, fusco, asperato: foliis subconfertis, elliptico- vel spathulato-oblongis, apice obtuse acuminatis, raro acutioribus, imo cuneatis, serrulatis, dentibus obtusis sæpe mucronulatis, rigide chartaceis vel subcoriaceis, supra saturate viridibus vel pallidioribus, opacis, sub lente (præsertim in nervis) granulis minutis asperatis, nervis tenuibus paullo prominulis, costa subimmersa, subtus pallidioribus, opacis, sæpe dealbatis, glaucis vel fulvidis, nervis costaque prominulis reticulatis; petiolo supra plano aut sulcato, marginato, subtus corrugulato, limbo 15–20plo breviore: racemo terminali, spicatifloro, pendulo, folio duplo aut ultra longiore; rachi subtenui; floribus subapproximatis, longiuscule pedicellatis; sepalis 4, ovatis, membranaceis, ciliatis; petalis 6plo longioribus, 4, oblongis, carneis vel intense rubris, extus carinatis, marginibus ciliatis; staminibus coccineis; ovario infero, turbinato, acute 4-angulato, 2-loculari, ovulis in loculis suspensis: fructu oblongo, utrinque subangustiore, calyce coronato; pericarpio coriaceo, interrupte plurisulcato, acute tetragono, angulis tenuiter nerviformibus, abortu 1-loculari et monospermo; semine oblongo, profunde parallele sulcato, solido. Arbores in Indiæ peninsula undique sparsæ: *v. s. in herb. Hook.* penins. Ind. (*Wight* 1083), Travancore (*Wight* 1062), Madras (*Wall. Cat.* 3635 G), N. W. Ind. (*Royle*), Serampore (*Edgeworth*), Afghanistan (*Ritchie* 286), in planit. Ganges (*Thompson*), in hort. Calc. cult. (*Griffith* 2424); *in hb. Soc. Linn.* hort. Calc. cult. (*Wall. Cat.* 3635 E), ex hb. Roxburgh (in *Wall. Cat.* 3635 F), ex hb. Finlayson (*Wall. Cat.* 3635 L); *in hb. Sir J. Smith.*

The several plants from all parts of the Indian peninsula above indicated are here considered to be the same as the *Barringtonia acutangula*, Roxb.; but they may require further revision.

Blume and Roxburgh looked upon this species as the *Tsjeria Saamstravadi* of Rheede (Hort. Mal. tab. 7); but they were misled into this opinion by the circum-

stance, not noticed by them, that the *Saamstravadi* in that place is reduced to half its natural size: that plant is the *Butonica rubra*, nob. (*ante*, p. 70). At the same time, Roxburgh, Wight, and others considered this species to be identical with the *Eugenia acutangula* of Linnæus and of Gaertner; but there is ample evidence to prove the contrary. This plant closely approaches *S. demissum*, a species apparently confined to the Malay provinces and adjoining islands; but it differs in its smaller and paler flowers. Roxburgh says it is a large handsome tree, in appearance like a regular and well-shaped middle-sized Oak, with slender branches; its leaves vary in size from 3–6½ in. long, 1⅝–2½ in. broad, on petioles 3–6 lines long; the raceme is 6–10 in. long, the flowers 3 lines apart, on pedicels 1–2 lines long; the sepals are ½ line long and broad, the petals 3 lines long; the immature fruit is 1¼ in. long, ½ in. broad; the embryo of the seed when in a fresh state has a savoury taste, but afterwards becomes bitter.

5. Stravadium pubescens, nob.: *Barringtonia acutangula*, W. & A. (non Roxb. nec Gaertn.), Prodr. Fl. Ind. p. 335 (in parte et excl. synon.): ramulis subangulatis, rugoso-striatis, ex cinereo vel rufescente brunneis, subpuberulis vel glauco-pruinosis: foliis elliptico-oblongis, apice latioribus, obtusis aut brevissime apiculatis, imo sensim subacutis, sæpe cuneatis, subserrulatis, dentibus mucronulatis, chartaceis, supra pallide viridibus, nervis tenuissimis subimmersis, venis transverse reticulatis, subtus sæpe pallidissimis, opacis, costa nervisque prominentibus, brevissime tomentellis, præsertim in nervis; petiolo subcrasso, imo latiusculo, puberulo, supra plano, limbo 10plo breviore: racemis sæpe in ramulis novellis brevibus terminalibus, folio 3–6plo longioribus, rachi tenui, angulata, griseo-puberula, spicatiflora; floribus pedicellatis; pedicellis imo bracteola parvula squamiformi æquilonga munitis; sepalis 4, parvis, rotundatis, extus puberulis, membranaceis, ciliatis; petalis 4, oblongis, triplo longioribus, pallide roseis, raro intensioribus; ovario infero, turbinato, tetragono, aspere puberulo, 2-loculari. In Indiæ peninsula: *v. s. in hb. Hook.* Coromandel (*Konig, Roxb. in Wall. Cat.* 3635 B), Concan (*Dalzell*), Carnatic (*G. Thompson*), Indiæ penins. (*Wight* 1062–1080), Courtallam (*Wight* 1063; *in Wall. Cat.* 3635, *ex hb. Wight*).

This species, which seems confined to the more southern provinces of the Peninsula, is very near the preceding, differing among other characters in its singular pubescence. Its leaves are 2½–5 in. long, 1½–2½ in. broad, on petioles 3–6 lines long; the racemes are 12–18 in. long, pedicels 1 line long, sepals ½ line long, petals 3 lines long; the fruit is unknown.

6. Stravadium coccineum, DC. Prodr. iii. 289: *Meteorus coccineus*, Lour. Coch. Chin. ii. 449: arbor magna, ramis tortuosis, adscendentibus, ramulis crebre striatis: foliis subsparsis, elliptico-oblongis vel obovatis, apice obtusis aut vix acutis, imo sensim cuneatis, ad marginem subintegrum obsolete crenato-serrulatis, rigide chartaceis, supra subhepaticis, opacis, nervis rufulis costaque plana subprominulis valde reticulatis, subtus flavide opacis, sub lente minutissime granulatis, nervis flavescentibus costaque prominentibus; petiolo supra plano, limbo 12–16plo breviore: racemis

terminalibus, folio triplo longioribus, pendulis; rachi gracili, hepatica; floribus alternatim spicatis; pedicellis tenuibus, angulatis, fuscis, sepalis triplo longioribus; sepalis 4, parvis, ovatis, pallidis, marginibus membranaceis, ciliolatis, extus pulverulento-puberulis; petalis 4, triplo longioribus, oblongis, membranaceis, coccineis vel roseis, cum staminibus intense purpureis, disco styloque ut in char. gen.; ovario infero, turbinato, octagono angulis 4 acutioribus, vertice intra disci urceolum latum concavato, 2-loculari, ovulis in quoque loculo 2, suspensis: drupa late oblonga, obtuse octagona, glabra, fusca, calyce coronata, abortu 1-loculari et 1-sperma: semine magno, duro, rotundato. In Cochin-China: *v. s. in hb. Mus. Brit.* plantam typicam (*Loureiro*); *in hb. Hook.* Siam (*Schomb.* 182–309).

A tree of considerable size, growing in woods, very distinct from *Butonica terrestris*, with which it has been confounded. Its leaves are 4–5 in. long, 1¾–2 in. broad, on petioles 3–5 lines long, and with about 10 pairs of nerves. The racemes are 10–18 in. long, with flowers 3–5 lines apart, on pedicels 3 lines long, having a small deciduous bract at their base; the sepals are 1 line long, the petals 3 lines long; the size of the fruit is not stated. Loureiro describes the corolla as monopetalous, not observing that the petals were agglutinated to the staminiferous tube.

7. Stravadium luzonense, nob.: *Botryoropsis luzonensis*, Presl, Epim. Bot. p. 220; Miq. Fl. Ned. Ind. i. 492; Walp. Ann. ii. 642: ramulis dichotomis, subtenuibus, cinereo-brunneis, striolatis, apice confertim foliiferis: foliis oblongo-ellipticis, apice in acumen breve acutum constrictis, imo subcuneatis et in petiolo brevi decurrentibus, marginibus basin versus reflexis, undique serrulatis, dentibus erectis, subuncinatis, apice acute mucronulatis, flaccide chartaceis, supra rufescenti-viridulis, opacis, nervis arcuatim adscendentibus reticulatis, subtus pallidis, opacis, nervis paullo prominentibus; petiolo brevissimo, semitereti, acute marginato, limbo 30plo longiore: racemo terminali, longiusculo; rachi tenuissima, striolata, spicatiflora, rufescente, ebracteolata; floribus plurimis, pedicellatis; sepalis 4, rotundatis, margine late pallideque membranaceis, setulis rufulis ciliatis; petalis 4, oblongo-ovatis, 4plo longioribus, marginibus membranaceis, erosulis; filamentis hæc excedentibus, crenulato-crispatis; disco angustissime annulari, margine interno in tubum crassum erectum ore lato integrum expanso; ovario infero, turbinato, tetragono, angulis sepalis alternis, pedicelloque pilis rigidis rufulis puberulo, 2-loculari, ovulis 2 in quoque loculo apici dissepimenti affixis. In ins. Philippinis: *v. s. in hb. Hook. et Mus. Brit.* Laguna in Luzon (*Cuming* 653, 1268).

I have given the above diagnosis from my own observations. The genus *Botryoropsis* of Presl, formed on Cuming's plant (658), which I have carefully examined, differs in no respect from *Stravadium*. He was certainly wrong in attributing to it opposite branches and leaves; the 2-celled ovary and the broad tubular expansion of the inner margin of the disk are present in the preceding and all other species; indeed the latter feature differs only in degree, and is therefore of no more than specific value; the stamens are very numerous, and at least 6-seried; and the anthers differ in no respect from the others; the ovules are affixed to the summit of the dissepiment; in fine, there is no generic

distinction whatever. This species differs from the preceding in little more than in its smaller and narrower leaves, which are $2\frac{1}{2}$–5 in. long, 1–2 in. broad, on petioles 1–2 lines long; the raceme is 9 in. long, the pedicels 1 line, the ovary $\frac{1}{2}$ line, the sepals 1 line, and the petals 3–4 lines long.

8. STRAVADIUM SPICATUM, Blume, in DC. Prodr. iii. 289, et in Van Houtte, Flor. Serr. vii. 24: *Barringtonia spicata*, Blume, Bydr. 1097; Miq. Fl. Ned. Ind. i. 489; Vriese, Ned. Kruidk. Arch. iii. 41: ramulis rugosis, apice crebre foliosis: foliis longe ellipticis, apice sensim acutis aut breviter acuminatis, imo cuneatis, irregulariter crenato-serratis, dentibus obtusis aut subacutis, intus sæpe acute mucronulatis, tenuiter chartaceis, supra viridibus, opacis, nervis tenuissimis divaricatis vix prominulis, venis reticulatis, subtus pallidioribus, opacis, costa striolata nervisque prominulis; petiolo tenui, semitereti, limbo 20plo breviore: racemo terminali, longissimo, pendulo, rachi tenui, angulata; floribus spicatis, subcrebris vel sparsioribus; pedicellis brevibus; sepalis parvis, ovatis, pallide membranaceis, denticulis rubellis acutis ciliolatis; petalis 4, duplo longioribus, oblongis, unguiculatis, staminibus styloque ut in char. gen.; ovario turbinato, tetragono, 2-loculari, ovulis in quoque loculo 2, pendulis: fructu (sec. cl. Blume) ellipsoideo, utrinque obtuso, tetragono, costato-rugoso. In Javæ prov. Bantam, in sylvis paludosis: *v. s. in hb. Hook.* Java (*Zollinger* 534*), Java (*De Vriese*, sub *Barringtonia spicata*); *fruct. non vidi.*

A species distinct from *S. Horsfieldii* and *S. reticulatum*. Its leaves are 3–5 in. long, $1\frac{1}{2}$–2 in. broad, on petioles 4–6 lines long. Their dimensions agree with those given by Blume, who adds that they are sometimes (the lower ones?) 8 in. long and 3 in. broad; the slender rachis is 12–15 in. long, with rather small flowers, either sparsely or more thickly spicated. Blume asks whether this is the same as the *Carya macrostachya* of Jack, which certainly it is not, as the latter presents a thick cylindrical rachis, with much larger flowers, and belongs to the genus *Doxomma*. Miquel, with his usual carelessness, first copies the diagnosis of Blume as to the dimensions of the leaves, but afterwards, in contradiction, gives a much smaller size to the leaves—2 in. long, $1\frac{1}{2}$–2 in. broad, and therefore almost orbicular in shape.

9. STRAVADIUM HORSFIELDII, nob.: *Barringtonia Horsfieldii*, Miq. Fl. Ned. Ind. i. 489: ramulis tenuibus, ligneis, subfistulosis, rugulosis, axillis approximatis: foliis obovatis, apice rotundatis vel obtusatis et in acumen obtusulum breve latum subito constrictis, imo acute cuneatis, inæqualiter serrulato-dentatis, dentibus sæpe breviter spinuloso-mucronatis, subchartaceis, supra læte viridibus, opacis, nervis tenuissimis patule divaricatis paullo prominulis, subtus pallidioribus, nervis venisque reticulatis, prominulis; petiolo tenuissimo, semitereti, limbo 8plo breviore: racemo in ramulis brevibus alaribus terminali, spicato, folio 6plo longiore; rachi tenui, flexuosa, griseo-puberula, pluriflora; floribus alternis, sessilibus, imo bracteola decidua munitis; sepalis 4, distinctis, rotundatis, subito acutis, denticulatis, puberulis; petalis 4, ovato-oblongis, marginibus crenulatis 4plo longioribus; staminibus pluriseriatis,

imo altiuscule monadelphis; ovario infero, turbinato, subtetragono, biloculari, ovulis in quoque loculo 2, funiculis suspensis. In Java: *v. s. in hb. Mus. Brit. et Hook.* Prowatt (*Horsfield*).

A species near *S. spicatum,* but with much smaller leaves. In the above specimens the leaves are 3–4½ in. long, 1½–2½ in. broad, on petioles 5–6 lines long, with about 8 or 10 pairs of nerves; rachis of raceme 12–18 in. long; flowers frequently in pairs, 3–5 lines apart; sepals ½ line long; petals 4 lines long; ovary strigosely puberulous, yellowish. Miquel describes the leaves as being 2¾–4 in. long, ¾–1½ in. broad, on petioles ½ in. long, with 7–10 pairs of nerves.

10. Stravadium globosum, nob.: *Gustavia globosa,* Spanagh. Linn. xv. p. 204: *Perigara globosa,* Span. *l. c.* 204: ramulis subvalidis, fusco-opacis, striolatis: foliis oblongis, supra medium obtusis, apice in acumen breve subito constrictis, imo cuneatis, pallidissime opacis, crenato-serratis; petiolo semitereti, supra plano, limbo 10plo breviore: racemis axillaribus, folio longioribus; rachi gracili, pendula, pallide opaca, angulata, pilis albidis rigidulis scabridulis; floribus parvis, alternatim subsessilibus; sepalis rotundatis, membranaceis, dentibus rubidulis, fimbriatis, subpuberulis: ovario turbinato, rigide puberulo, 2-loculari: fructu parvo, globoso, abortu uniloculari, monospermo; semine globoso, ab apice suspenso. In Java: *v. s. in hb. Hook.* loc. cit. (*Anderson*), ex Hort. Bogor. cultam (sub nom. *S. spicatum*), cum fructu immaturo.

Leaves much approximated at the ends of the branchlets, 6–6½ in. long, 2½–2¾ in. broad, on slender petioles 7–8 lines long; acumen 2 lines long and broad; sepals 1 line long and broad; ovary 1 line long: fruit (probably immature) 8 lines in diameter; pericarp 1 line thick; immature seed 3 lines in diam., shown on a longitudinal section in the specimen above cited.

11. Stravadium gracile, nob.: *Barringtonia acutangula,* Benth. (non Gaertn.) Flor. Austr. iii. 288: arbor magna, ramulis tenuibus, apice creberrime foliosis: foliis elliptico-oblongis, apice sensim angustioribus, et in acumen breve obtusulum subito constrictis, imo gradatim cuneatis, margine breviter serrulatis, dentibus obtusis, callosis, flaccide chartaceis, utrinque pallidissimis, pruinoso-opacis, sub lente granuloso-punctulatis, costa nervisque tenuissimis, subarcuatim divaricatis paullo prominulis, reticulatis, subtus costa striolata nervisque albescentibus prominulis; petiolo tenui, planato, subtus striolato, limbo 36plo breviore: racemo terminali, spicato, longissimo, pendulo; rachi tenui, angulata, fusca, pluriflora; floribus pedicellatis; pedicellis longissimis tenuissimis e nodis globosis callosis albidis ortis, imo bractea majuscula cuneato-oblonga foliosa, dimidio breviore, alteraque minima rotundata membranacea squamiformi munitis; sepalis 4, ovatis, submembranaceis, denticulatis; petalis 4, oblongis, concavis, submembranaceis, denticulatis, rubellis; ovario infero, turbinato, fusco, acute tetragono, 2-loculari, ovulis in quoque loculo 2 suspensis: fructu ovato-oblongo, tetragono, angulis acutis utrinque sublobatis. In Australia septentrionali: *v. s. in hb. Hook.* Victoria River (*Mueller*), Adam's range (*Mueller*).

A large handsome tree: but there are probably two species here; for Mueller states that in one variety the larger perspicuous bracts are wanting, but the minute membranaceous rounded scales remain. The leaves are $2\frac{1}{2}$–$5\frac{1}{2}$ in. long, 1–2 in. broad, on petioles 3–4 lines long; the slender graceful raceme is 18 in. long, with flowers 2–3 lines apart; pedicels 6 lines long; bracts 4 lines long, 2 lines broad; sepals 3 lines long; petals 7 lines long; ovary 3 lines long; fruit $1\frac{1}{4}$ in. long, $\frac{3}{4}$ in. broad, pedicellated, of a brownish colour when dried.

12. Stravadium reticulatum, Bl. in Van Houtte, Flor. Serr. vii. p. 24: *Barringtonia reticulata*, Miq. Fl. Ind. i. 494: *Barringtonia acutangula*, Korth. (non Gaertn. nec Roxb.) in Kruidk. Arch. i. p. 296: ramulis pallide brunneis, opacis, striolatis: foliis oblongo-lanceolatis, apice sensim vel breviter acuminatis, imo cuneatim attenuatis, argute serratis, subcoriaceis, nervis utrinque circa 12 divaricato-adscendentibus, venis valde reticulatis, costa prominente, subtus pallidioribus; petiolo subtenui, supra plano, limbo 10plo breviore: racemo terminali, longe spicato, pendulo, folio 4plo longiore; floribus subapproximatis, pedicellis tenuibus, angulatis; sepalis 4, ovatis, membranaceis, denticulatis, medio crassioribus, pube brevissima asperatis; petalis 4, obovatis, 3plo longioribus, membranaceis, coccineis, integris, unguibus tubo staminigero adglutinatis, cæteris ut in char. gen.; ovario ovato, infero, rufulo, rigide puberulo, 2-loculari, ovulis in quoque loculo 2, dissepimento pendulis: fructu ellipsoideo, calyce coronato, acute 4-angulari, costis rugulosis. In Borneo in uliginosis et ins. Philippinis: *v. s. in hb. Hook.* Barmassing (*Motley* 53, 582, 720), ins. Phillipin. (*Cuming* 1835).

It is described as a small tree, with long slender racemes adorned with scarlet flowers. The fruit, which I have not seen, is said to be edible. The leaves are 5–$6\frac{1}{2}$ in. long, $1\frac{1}{2}$–2 in. broad, on petioles 6–9 lines long; the raceme is 18 in. long, with a slender subcompressed rachis, slender pedicels 3 lines long; the sepals are 1 line long; petals 3 lines long; stamens 4 lines long: the disk on its inner margin has a sharp elevated edge. In Blume's account there is a mistake in the length of the petioles, which are $\frac{1}{2}$–$\frac{3}{4}$ in., as Miquel rightly states.

13. Stravadium serratum, nob.: *Barringtonia serrata*, Miq. Fl. Ned. Ind. i. p. 488; Walp. Ann. iv. 851: foliis lanceolato-oblongis, apice in acumen breve obtuse acutum constrictis, imo cuneatis, marginibus imum versus repando-dentatis, summum versus subremote et argute spinuloso-serratis, flaccide chartaceis, nervis inferioribus tenuioribus patulis, reliquis validis et erecto-patulis, venis reticulatis: racemis elongatis, subpendulis; pedicellis sepalorum longitudine dupla; sepalis obtuse rotundatis et denticulatis; petalis flavido-roseis; ovario turbinato, tetragono, angulis prominulis. In Java, prov. Tjimarra: *non vidi.*

The leaves are 12–17 in. long, $3\frac{1}{2}$–$4\frac{1}{2}$ in. broad, on petioles $1\frac{1}{2}$–2 lines long; length of raceme not given; pedicels 6 lines long; sepals 3 lines long; number of cells in ovary not stated. From its ciliated sepals, we may infer that it belongs to *Stravadium.*

14. STRAVADIUM REINWARDTII, nob.: *Barringtonia Reinwardtii*, Miq. in Fl. Ned. Ind. i. p. 488; Walp. Ann. iv. 851: foliis obverse oblongis vel obovato-oblongis, apice acuminatis, imum versus sensim attenuatis, tenuiter coriaceis, undique subspinulose serratis, nervis costatis utrinque circ. 12 erecto-patulis, venis reticulatis; petiolo brevissimo: racemo longissimo, pendulo, rachi crassiuscula; floribus pedicellatis; sepalis 4, obtusis, ciliato-erosulis; petalis late ellipticis, obtusis, superne tenerrime ciliolatis. In Java: *non vidi.*

Leaves 9–11 in. long, 3–4 in. broad, on petioles 1½–2 lines long; raceme 2½ feet long; pedicels 2–3 lines long; sepals about 3 lines long; petals nearly 1 inch long.

15. STRAVADIUM COSTATUM, Bl. in Van Houtte, Fl. Serr. vii. p. 24: *Barringtonia costata*, Miq. Fl. Ned. Ind. i. p. 489: foliis lanceolato-oblongis, apice acutis vel breviter acuminatis aut obtusioribus, imo cuneato-attenuatis, serrulatis, nervis costulatis; petiolo limbo 12plo breviore: racemis longissimis, pendulis; floribus pedicellatis, pro genere parvulis; petalis rubris: fructu obconico, subtetragono, costato. In ins. Sundaicis, sylvis humidis depressis: *non vidi.*

A species said to differ from *S. spicatum* in its smaller pedicellated flowers, and fruit attenuated at its base. Its leaves are 3–6½ in. long, 1–2½ in. broad, on petioles 3–6 lines long; racemes more than a foot long. Miquel has referred here the *Careya macrostachys* of Jack; but this mere guess cannot for a moment be entertained.

16. STRAVADIUM LUCIDUM, nob.: *Barringtonia nitida*, Miq. in Fl. Ned. Ind. i. 490: foliis obverse oblongis, obtusis vel obtusiusculis, imo attenuatis, irregulariter sinuato-serrulatis, tenuiter chartaceis, supra nitidis, costa tenui, nervis adscendenter divaricatis utrinque 8–12 tenuibus paullo prominulis, subtus pallidis, opacis, costa striolata prominula compressa, nervis venisque transversim reticulatis prominulis; petiolo semitereti late marginato, limbo 20plo breviore: racemis plurimis, spicatis, longissimis, pendulis, patule griseo-pubescentibus; floribus sessilibus; calycis limbo poculiformi in sepala 4 obtuse ovata diviso, pubescente, marginibus glabris membranaceis eroso-ciliatis; ovario adpresse hirtello. In Java: *v. s. in hb. Mus. Brit.* Bantam, prov. Sourabaja (*Horsfield*).

Horsfield's specimen agrees in character with Miquel's description of this plant (which is also from Bantam), only that the leaves are somewhat larger, and probably from a more matured specimen. They appear identical; but I have changed the specific name, that it may not be confounded with the *Planchonia nitida*, Bl. In Horsfield's plant the leaves are 3½–7½ in. long, 2½–3⅝ in. broad, on petioles 3–5 lines long; the racemes have all fallen off; only the bottom of one remains, bearing a single half-grown fruit. Miquel states that the leaves are 3½–5 in. long, 1½–1¾ in. broad, on petioles 2–3 lines long; the racemes are 12–18 in. long.

17. STRAVADIUM DENTICULATUM, nob.: ramulis tenuibus, pallidis, sulcato-striatis; foliis lanceolato- vel longe oblongis, apice sensim acutis, imo cuneatis, margine subcrebre

serrulatis, chartaceis, supra pallide viridibus, opacis, nervis paullo divergentibus, subimmersis, tenuiter reticulatis, subtus pallidissimis, opacis, costa tenui, albida, prominula, nervis pallidissimis vix prominulis; petiolo angusto, utrinque marginato, subtus striolato, limbo 16plo breviore: racemo terminali, folio longiore, pendulo, glaberrimo, rachi subtenui, spicatiflora; pedicellis tenuissimis, 4-angulatis, sepalis longioribus; sepalis 4, ovatis, submembranaceis, marginibus undulatis, ciliato-denticulatis; petalis 4, triplo longioribus; staminibus numerosis, petalis multo longioribus, 4-seriatis; disco extus tubum staminigerum fulciente, interne in urceolam erectam ore latam et undulatam producto; stylo subulato, tenui; stigmate parvo, bilobo; ovario infero, parvo, acute 4-angulari, 2-loculari. In Australia: *v. s. in hb. Hook.* Cape York (*Hann* 195).

The leaves are 4–8¾ in. long, 1⅝–3 in. broad, on petioles 3–6 lines long; raceme 11 in. long, with slender pedicels 4 lines long; sepals 1 line long; petals 3 lines long; stamens 7 lines long; style 7 lines; ovary 1 line long.

18. Stravadium semisutum, nob.: ramulis teneris, striolatis: foliis in summo ramulorum subconfertis, oblongo-ellipticis, apice sensim acutis aut breviter constrictis, infra medium subcuneatis, subserrulatis; petiolo subtenui, limbo 20plo breviore: racemo terminali, longissimo, pendulo, rachi tenui, angulato-striata, spicatiflora; floribus subsparsis, aut sæpe per paria approximatis, pedicellis tenuibus, patulis, sepalis æquilongis; sepalis obtuse oblongis, glabris, marginibus subrevolutis ciliatis, quorum 2 semper in unum latius semicoalitis; ovario infero, tetragono, sub-8-costato, disco plane annulari, intus in urceolam erectam crenulatam producto, vertice hinc profunde cavato, stylo subulato glabro sepalisque coronato, 2-loculari, ovulis in quoque loculo 2 suspensis. In Insulis Navigatorum: *v. s. in hb. Hook.* Falaga, Samoa (*Powell* 46).

A species remarkable for the semiagglutination of two of its four sepals, which are rather larger and thicker than usual in the genus; this seems to be a constant character, and apparently occurs in the following species from the neighbouring island of New Caledonia. The leaves, approximated on the branchlets, are 4¾–7¼ in. long, 2–2¾ in. broad, on petioles 3–4 lines long: the slender terminal rachis is gradually bent till it becomes pendulous, is 20 in. long; the flowers are 1–5 lines apart, on spreading pedicels 2 lines long; the sepals are 3 lines long, the style 2½ lines long; the petals and stamens are all fallen off.

19. Stravadium integrifolium, Montrouzier in Mém. Acad. Lyon, vol. viii. (1858) p. 309: *Barringtonia Montrouzieri*, Vieill. in Bull. Soc. Linn. Normand. x. (1866) p. 11: arbor, foliis apice ramulorum confertis, obovato-oblongis, apice acuminatis, imo cuneatis, integerrimis, marginibus undulatis, glabris, reticulato-nervosis, vix petiolatis: racemis axillaribus, longe pendulis, laxifloris, bracteis imo involucratis; sepalis 2 v. 3 v. 4, subacute ovatis, concavis, marginibus apice coloratis; petalis 4, sepalis longioribus, albidis; staminibus disco styloque ut in char. gen.; ovario infero, turbinato, 2-loculari, ovulis in quoque loculo 2: fructu oblongo, compresso, sæpe arcuato,

4-angulari, angulis sinuato-alatis, abortu 1-loculari et monospermo. In Nova Caledonia et ins. Art, juxta rivulos: *non vidi.*

A tree 26–33 feet high, growing in valleys; its leaves are 7–8 in. long, $2\frac{1}{2}$–3 in. broad, and subsessile; its racemes are $1\frac{1}{2}$–2 feet long, with laxly spicated flowers; the fruit, with 4 very undulated wings, and crowned by the calycine lobes, is 5 in. long and $1\frac{1}{4}$ in. broad; the pericarp is fibrous, and, when the fruit has fallen to the ground, rots after a while, and a root protrudes like that of a radish. This species presents the peculiarity of the preceding species: of its sepals, often entire, two or three are sometimes partly conjoined.

5. Planchonia.

This genus, proposed by Blume, was first published in 1852, in Van Houtte's 'Flore des Serres;' he had, however, as far back as 1828, described its seminal features in De Candolle's 'Prodromus,' upon a plant referred by him to *Gustavia*, the seminal characters of which were then unknown. Long prior to this, the first known species of this genus was found in 1770, in Queensland, by Dr. Solander, and afterwards, in the Gulf of Carpentaria, by the late Mr. Robert Brown, who in 1803 discovered it to be a new genus, and then described the plant under the name of *Butonicoides crenata*, in a memoir never published, but which is still preserved in the British Museum. He changed its name to *Careya crenata* in 1819, when Roxburgh first established the latter genus, of which the internal structure of the seeds was unknown. *Planchonia* agrees with *Careya* in habit and the form of its fruit, which also contains many seeds, enveloped in pulp; but the embryo in the former is dicotyledonous, as in *Barringtonia*, while in *Careya* it is analogous to that of all other genera of the family. Brown's description of this genus is far more accurate and copious than that of Blume. Succeeding botanists gave very laconic characters of four or five species; but Miquel, in 1855, created confusion by combining them all into two species, with characters almost useless for the purpose of distinction. I have carefully examined Brown's typical plant, and have compared this with his original notes. With the analysis I have made of other, more recent specimens from another part of Australia, and from those materials, the following generic character is formed:—

Planchonia, Blume (olim *Gustavia*, Bl.).

Butonicoides, R. Br. MS.; *Careya* (in parte), R. Br. et Benth.; *Eugenia*, Soland. MSS.

Sepala 4, distincta, rotundata, subcoriacea, æstivatione paullo imbricata, persistentia. *Petala* 4, triplo longiora, cuneato-oblonga, reflexa, unguibus tubo staminifero agglutinata et cum illo caduca. *Stamina* numerosissima, pluriseriata, in tubum brevem monadelpha; *filamenta* filiformia, petalis longiora, æstivatione contortuplicata, nonnulla anauthera. *Discus* epigynus, plane annularis, margine externo tubum staminiferum fulciens, interno in urceolum breviter erectum ore lato expansum; *stylus* tenuiter subulatus, stamina subæquans. *Stigma* parvum, 4-lobum aut fimbriatum. *Ovarium* inferum, turbinatum, vertice intra discum concavum, 4-loculare; *ovula* in quoque loculo plurima, funiculis ad axem radiatim affixa. *Drupa* ovato-oblonga, utrinque obtusa, calyce coronata, extus leviter opace granulosa, abortu 3- 2- vel 1-locularis: *pericarpium* molliter coriaceum, subcrassum, lignose fibrosum; *semina* in loculis pauca vel plura, in *pulpa* pannosa nidulantia, *funi-*

culo brevi lato munita, ovata, compressa; *integumentum externum* tenuiter membranaceum (R. Br.), evanidum; *albumen*? (aut *integumentum internum*) album, crasse carnosum, subfirmum; *embryo* inclusus; *radicula* longiuscula, valida, teres, supra medium subito inflexa, et hinc inæqualiter bicrura, crure longiore raphæ proximo ad hilum spectante, crure altero parallelo breviore cotyledones 2 gestante; *cotyledones* brevissimæ, ovatæ, erectæ, applicitæ, incumbentes, tenuiter foliaceæ, marginibus integris (vel paucidenticulatis, *R. Br.*, aut plicatæ ,*Blume*).

Arbores in insulis Moluccensibus vel in Australia boreali vigentes, *frondosæ*; folia *alterna, oblonga vel orbiculata, crenato-serrata, glabra, petiolata*; inflorescentia *terminalis aut in ramulis novellis superioribus, brevissime ramosa, hinc pseudo-paniculata*; flores *speciosi*.

1. PLANCHONIA CRENATA, nob.: *Eugenia crenata*, Soland. MS.: *Careya crenata*, R. Br. in MS. ined. no. 75, in Mus. Brit. (olim *Butonicoides crenata*, R. Br. *l. c.*): *Careya arborea*, var. *australis*, Benth. (non Roxb.) in Flor. Austr. iii. p. 288: arbor ramis expansis, iterum ramulosis, ramulis 3 ultimis floriferis, brevibus, crassiusculis, pallide brunneis: foliis late ovalibus, apice in acumen sæpe lineare mucroniforme subito constrictis, imo in petiolum longiusculum breviter acutatis, margine crenulato-serrulatis, supra pallide viridibus, nervis tenuibus vix immersis, subtus paullo pallidioribus, costa carinata albicante, nervis prominulis; petiolo tenui, acute marginato, limbo 4plo breviore: racemis subaxillaribus, solitariis, aut in ramulis novellis terminalibus, paucifloris; rachi valida, longiuscule nodosa; pedicellis brevissimis, ad nodos articulatis, 1-floris, flore hinc sæpe caduco; calycis limbo imo brevissime cupulato, cum sepalis 4 rotundate ovatis vel oblongis, coriaceis, fuscis, marginibus membranaceis subciliatis; petalis 4, oblongis, unguibus tubo staminigero agglutinatis; staminibus numerosissimis imo in tubum brevem monadelphis; disco margine externo staminifero, interno in tubulum brevissimum membranaceum undulatum expanso; stylo filiformi, valde incurvo; stigmate parvo, obtuse lobato; ovario infero, turbinato, vertice intra discum valde concavo, 4-loculari, ovulis plurimis biserialiter axi affixis: drupa elliptica, oblonga, lævi, viridi, sicca pallide brunnea, calyce styloque coronata; pericarpio crassiusculo, fibroso-coriaceo, 4-loculari, aut abortu loculo unico maturescente, polyspermo; seminibus compresse ovalibus, in pulpam pannosam immersis, integumento fusco membranaceo tectis; albumine? aut integumento interno? carnoso-coriaceo, primum viridi, demum albo; embryone ut in char. gen. In Australia: *v. s. in hb. Mus. Brit.* Cape Grafton (*Banks et Solander*), Carpentaria Bay (*R. Brown*); *in herb. Hook.* Port Darwin (*Schomb.* 347), Victoria River (*Mueller*): *v. fruct.* cum sp. R. Br. et Schomb.

These ample details, derived principally from Brown's notes and specimens, are fully confirmed by all the others which I have seen. Brown describes it as a large or middle-sized tree, with a thick trunk and a spreading comose head; the branchlets are marked by numerous cicatrices of the fallen leaves, which are $\frac{1}{2}$ in. apart; the leaves, thus somewhat crowded, are 4–4$\frac{1}{2}$ in. long, 2$\frac{3}{4}$–3 in. broad, on a slender petiole 9–10 lines long, and have about 16 pairs of parallel nerves, 3 lines apart. In Schomburgk's specimen from Port Darwin, the inflorescence is axillary, short, with few flowers upon a rather slender rachis; the pedicels alternate, 2 lines long, articulated on a prominent node; the ovary,

3 lines long, is crowned by the tubular free portion of the calyx 1 line deep, surmounted by 4 erect, rounded, coriaceous sepals 3 lines long; the petals are 8 lines long, 3 lines broad. It is accompanied by a single loose fruit, 2 in. long, 11 lines broad, very ventricose on one side, straight on the other, owing to the abortion of 3 of its cells; the remaining cell contains 4 seeds 4 lines long, with the hilum pointing to the straight edge; the pericarp, filled with woody fibres, is 3 lines thick. Brown's specimen presents a very different aspect, owing to the thickening of the rachis, which supports a matured fruit and another only half matured, in which the petals and stamens still remain; the rachis is about 4 in. long, very stout, with long persistent nodes, which, as in *Couratari*, support each one flower articulated upon it; the pedicel, 1 line long, presents at its base a cuneated oblong bract 12 lines long, 4 lines broad. The half-grown fruit is oval, 12 lines long, 7 lines broad, supporting the calycine tube, 2 lines deep, with its 4 sepals, the petals and stamens still remaining. The ripe fruit is quite oval, $1\frac{3}{4}$ in. long, $1\frac{3}{8}$ in. broad, crowned by the free portion of the calyx and style; the contents of the 4-celled pericarp are nearly all destroyed by insects; the axis, decayed pulp, and many seeds, mostly damaged, are still manifest, confirming the description of Brown. A section of Schomburgk's 1-celled fruit is shown in Plate IX. fig. 8; it is less destroyed by insects, and contains 4 horizontal seeds of the same shape and size, embedded in pulp, now reduced to loose grains; the outer thin integument has disappeared; but the inner thick coating (now white) remains; and in all four, at the apex, along one edge, there is a linear open slit, which extends to the cavity over the summit of the enclosed embryo; the embryo fills the cavity, is of the horseshoe-shape described by Brown; and I have given in fig. 14 a magnified view of the same. Brown, in his description, says, "albumen nullum;" but he described the thick inner coating (which, it appears to me, must be albumen) as being carnoso-coriaceous green when fresh, afterwards becoming white: it seems too thick for a mere integument, shows no sign of a raphe or chalaza; and being of a greenish colour, it responds more to the condition of albumen. Solander's specimen has no inflorescence, u t has two loose flowers, which correspond with the others above referred to.

2. Planchonia sundaica, Miq. in Flor. Ned. Ind. p. 493 (excl. synom.); Walp. Ann. iv. 852: *Planchonia undulata*, Tenn. & Ben. in Cat. Hort. Bogor.: foliis elliptico-oblongis vel obovatis, apice acute acuminatis, imo cuneatis, marginibus cartilagineis, valde undulatis, subrevolutis, integris vel obsolete serrato-crenatis, rigide chartaceis, supra fusco-viridibus, sublucentibus, subrufescentibus, nervis plurimis tenuibus rufulis prominulis, costa tenui subimmersa, subtus pallidioribus, brunneis, costa rubra nervisque prominentibus, transversim reticulatis; petiolo valido, marginibus latiusculis recurvatis, limbo 16plo breviore: racemo terminali, brevi; rachi crassa, angulata, crebre multiflora; nodis floriferis apice bracteolatis; floribus ad nodos subsessilibus; sepalis 4, parvis, acute ovatis, subcoriaceis, griseo-pruinosis, imo in tubum brevem coalitis; petalis obovatis, 3plo longioribus, carnosulis; ovario infero, cylindrico, 8-costato, vertice disco plano margine interno acute elevato, intus circa stylum valde concavo, 4-loculari, ovulis in quoque loculo pluribus, axi radiatim affixis:

drupa ellipsoidea, lævi. In Java: *v. pl. s. in hb. Hook.* in hort. Bogor. cult. (*De Vriese*), eodem loco (*Benedyk*, sub *P. undulata*); *fruct. non vidi.*

The leaves have a reddish hue; they vary in size, 3–8½ in. long, 1¾–4 in. broad, on a decurrent petiole 2–4 lines long; they have about 20 pairs of closely parallel nerves. The ovary is 2 lines long, the sepals 3 lines long, the petals 9 lines long, 4 lines broad, the many-seried stamens somewhat longer.

3. Planchonia nitida, Bl. in Van Houtte, Fl. Serr. iv. p. 24 (excl. synon.): foliis elliptico-oblongis vel ellipticis, apice acutis, acuminatis aut obtusis, imo cuneatis, margine inæqualiter sinuato-serratis, chartaceis, supra nitidis; petiolo limbo 9–12plo breviore: inflorescentia ignota: drupa ellipsoidea, lævi. In insulis Sundaicis: *non vidi.*

This species must not be confounded with the *Barringtonia nitida*, Miq., which is a *Stravadium.* There is nothing in the above laconic description to show that it belongs to *Planchonia.* Its identity with Blume's original *Gustavia valida* cannot be admitted, as the more accurate Hasskarl has given so excellent a character of the latter plant. It must therefore be considered a very doubtful species of *Planchonia.* Blume says that its leaves are 3–8½ in. long, 1¾–4 in. broad, on petioles 3–8 lines long.

4. Planchonia tetraptera, nob: *Gustavia alata*, Spanag. in Linn. xv. 204: *Myrtus alata*, Zeppell, *l. c.* 204: *Barringtonia acutangula*, Spanag. *l. c.* 204: *Planchonia timoriensis*, var. *alata*, Miq. in Fl. Ind. Ned. i. p. 493: *Planchonia timorensis*, Bl. in Van Houtte, Fl. Serr. vii. p. 25: ramulis junioribus alato-angulatis; foliis majusculis lanceolato-oblongis vel oblongo-ellipticis, apice in acumen breve obtusum apiculatis, imo cuneatis et in petiolo late decurrentibus, margine irregulariter crenatis, dentibus lateraliter mucronulatis; petiolo alato, marginibus in ramulo decurrentibus, limbo 8–12plo longiore: inflorescentia ignota: drupa ovoidea vel ellipsoidea, lævi. In ins. Timor: *non vidi.*

It is better to change the specific name *alata*, that the species may not be confounded with *Barringtonia alata*, Wallich. Blume referred this species to his *Planchonia timoriensis*, which he considered to be the same as the *Gustavia alata* of Spanaghoe, from Timor, with which the *Myrtus alata* of Zippel was regarded as identical: we recognize the same species in Miquel's var. *alata* of Blume's *Planchonia timorensis.* The species is distinguished by the broadly winged angles of its branches. The leaves, according to Blume, are 3¾–8 in. long, 2–3½ in. broad, on petioles 6–12 lines long, some of the leaves growing to a length of 17 in. according to Miquel. Miquel's variety *bimensis* may probably be a distinct species.

5. Planchonia elliptica, nob.: ramulis brunneis, opacis, striolatis: foliis ellipticis, apice obtusis et in acumen breve subito constrictis, imo cuneatis, marginibus cartilagineis inæqualiter crenulatis, rigide chartaceis, sæpe conduplicatis, supra (in siccitate) fuscis, rubescenti-brunneis, lucidis, nervis parallele divaricatis tenuibus costaque tenui prominulis, subtus pallide brunneis, nervis venisque transverse reticulatis

prominulis; petiolo fusco, revolutim marginato, limbo 8–9plo breviore: racemis in ramulis foliiferis, terminalibus, folio subbrevioribus; rachi erecta, crassiuscula, nodosa, nodis validis apice 1-floris (bracteatis?); floribus sessilibus; calyce cupulato 4-lobo, lobis semiovatis crasse coriaceis, intus pruinosis, extus granosis, fuscis; petalis 4, sepalis 4plo longioribus, oblongis, parallele nervosis, pruinosis, pallide roseis, unguibus tubo stamineo brevissime agglutinatis; staminibus numerosissimis, multiseriatis, petalis subæquilongis, imo in tubum longiusculum erectum monadelphis, nonnullis antheriferis, reliquis sterilibus; filamentis granulatim corrugulosis; stylo longo, tenui; stigmate breviter fimbriato; ovario infero, turbinato, subtetragono, corrugato, pruinoso, 4-loculari; disco epigyno plane annulari, margine exteriore tubum staminigerum gerente, intus fornicatim prominente, verticem concavum ambiente. In Borneo: *v. s. in hb. Hook.* Banjarmassing (*Motley* 750).

The raceme-bearing branchlets 2 in. long, with 2–4 leaves crowded toward the apex; leaves 3–4½ in. long, 1⅝–2⅜ in. broad, on petioles 4–7 lines long, and with about 12 pairs of parallel nerves 3 lines apart; terminal raceme 2 in. long, furnished with many crowded very beautiful flowers, sessile on the nodose expansions of the rachis, which are 1 line long and thick, and 1–2 lines apart; ovary 2 lines long, its crowning sepals 3 lines long; petals 13 lines long, 4½ lines broad; monadelphous tube of stamens 3 lines long, and 3 lines in diameter; stamens numerous, many of them sterile; ovary subtetragonous, 4-celled, with numerous ovules in each cell attached to the axis: their characters are quite those of *Planchonia*, to which this species is referred. Its fruit is unknown.

6. PLANCHONIA LITTORALIS, Bl. in Van Houtte, Fl. Serr. vii. p. 25: *Perigara valida*, Bl. (in parte) Bijdr. *l. c.* 1096: ramis rugulosis, striatis, junioribus pallide brunneis, opacis, vix striolatis: foliis ellipticis, vel elliptico-oblongis, apice in acumen subbreve subacutum angustissime obtusulum et subemarginatum constrictis, imo sensim et anguste cuneatis, margine subrevoluto cartilagineo inæqualiter sinuato serratis, dentibus erectis obtusis vel sæpius acute mucronulatis, chartaceis, supra pallide viridibus, opacis, costa tenuissima nervisque pallidis prominulis, venis valde reticulatis, subtus pallidioribus, costa striolata nervisque albescentibus paullo prominentibus; petiolo tenui, limbo 15plo breviore: inflorescentia ignota: drupa elongato-ellipsoidea, costatim subangulata. Java in maritimis: *v. s. in hb. Hook.* in hort. Bogor. cult. (*Anderson*, sub *G. valida*, sine flore aut fructu).

A species differing from *P. sundaica* in its broader, less acuminated, paler leaves, upon longer petioles. It is cultivated in the Bogor Gardens, probably introduced from one of the Sunda Islands. Its leaves, ¼–½ in. apart, are 4½–7½ in. long, 1¼–4 in. broad, on petioles 3–6 lines long. Blume considered it the same as his *Perigara valida*, because it is so named in the Bogor Gardens; but that is a very different species.

7. PLANCHONIA VALIDA, nob.: *Pirigara valida*, Bl. Bijd. 1096: *Gustavia valida*, DC. Prodr. iii. 290; Hassk. Bot. Zeit. (1844) xxvii. p. 595: procera: foliis ovali- vel late ellipticis, apice acute vel subretuse acuminatis, imo cuneatis vel retusis et in peti-

olo decurrentibus, margine denticulatis; petiolo lato, limbo 12–14plo breviore, marginato: inflorescentia ignota; sepalis 4 semiorbicularibus, ovario æquilongis, erectis; petalis 4plo longioribus, obtuse oblongis, viridiusculis, flaccidis, reflexis; staminibus quam hæc longioribus, pluriseriatis, filiformibus, imo in tubum sepalis longiorem monadelphis, imo sanguineis, apice albescentibus; disco epigyno plane annulari, extus tubum staminigerum gerente, margine interno in urceolum erectum expanso, vertice hinc profunde cavo; stylo longe filiformi, flexuoso, viridi; stigmate obtuso; ovario subturbinato, obsolete octagono, 3–4-loculari, ovulis in quoque loculo plurimis biseriatis. In Java et ins. Nusa Kambanga in sylvis: *non vidi*.

The excellent description of Hasskarl shows that this species belongs to *Planchonia*, which is confirmed by the seminal structure indicated by Blume eighteen years previously. Blume, however, confounded it with his *Planchonia nitida*, from which it is evidently distinct. It is described as a tall tree growing in woods; its leaves are 3–7 in. long, $2\frac{1}{2}$–$3\frac{3}{4}$ in. broad, on petioles 3–6 lines long, 3 lines broad; the ovary is 3 lines long; the sepals of the same length; the petals are 14 lines long, 6 lines broad; the staminiferous tube is 6 lines long, the filaments 18 lines long; the style is 24 lines long.

6. Careya.

A genus established in 1819 by Roxburgh in his 'Plants of Coromandel,' and acknowledged by all botanists: it consists of four species, natives of India and the Malayan peninsula, where they form trees of considerable size, with one exception, which is of low suffruticose stature. The inflorescence is extremely short, terminal on the nascent branchlets, with a thick fleshy rachis, bearing 1–4 very approximated sessile handsome flowers, each supported by 2 bracts, often of large size: the adnate calyx is surmounted by a cup-shaped limb, divided halfway into 4 rounded segments, which are subimbricated in the bud; 4 large obovate fleshy petals; the stamens, of unequal length, are very numerous, pluriserial and monadelphous at their base, and present the peculiarity that the outer and longer series, as well as the inner and shorter rows, are destitute of anthers, the intermediate series alone being antheriferous; the inferior ovary is usually 4-, rarely 5-celled, with several ovules in each cell, radiating from the central axis. The fruit is globose, about the size of an orange, is crowned by the persistent calycine limb, has a smooth coriaceous pericarp, normally 4-celled; but the dissepiments usually disappear, absorbed in the rather solid pulp, in which the many seeds are imbedded: the seeds are oblong, subcompressed, about the size of a field-bean, sometimes smaller; they have no albumen, have an external thick testa, covering a solid mesopodal embryo, which often begins to germinate in the ripe fruit. This embryo, as in other genera, though solid, is actually formed of two agglutinated layers, the outer of which (the exorhiza) was declared by Roxburgh and Wight to be the albumen, the inner (neorhiza) being regarded by them as an embryo with agglutinated indistinguishable cotyledons and radicle. Roxburgh, in a drawing copied by Wight, showed this seed in the act of germination; but this was afterwards better illustrated and explained by Dr. Thomson in the germinating seed of *Careya arborea*, where he showed there was no albumen, and that the inner body alone

(the neorhiza), by the protrusion of both extremities, produced at one end the growing leafy stem, at the other end the root of the new plant. Other observations of Dr. Thomson are of extreme importance, as explaining the progress of this growth. No doubt can now be entertained on this subject. Griffith gave several figures to illustrate the growth of a similar seed in a plant named by him *Careya pendula*, but which I have shown to belong to the genus *Doxomma*. The Australian species considered a variety of *Careya arborea* is *Planchonia crenata*.

CAREYA, Roxb.

Calycis adnati *limbus* breviter cupuliformis, fere ad basin in sepala 4 rotundata divisus, hæc in æstivatione subimbricata, in fructu persistentia. *Petala* 4, calyce multo longiora, cuneato-oblonga, expansa, unguibus tubo staminigero affixis et cum illo caducis. *Stamina* numerosissima, pluriseriata, petalis longiora, imo in tubum brevem erectum monadelpha : *filamenta* filiformia, inæquilonga, seriebus exterioribus longioribus, interioribusque brevioribus anantheris, intermediis solummodo fertilibus ; *antheræ* parvæ, subbilobæ. *Stylus* tenuiter subulatus, staminibus æquilongus incurvus. *Stigma* obsolete 4-lobum. *Discus* pulvinatim annularis, margine externo tubum staminigerum fulciens, interno in urceolum erectum expansus. *Ovarium* inferum, turbinatum, 4-loculare, vertice intra discum concavo ; *ovula* in quoque loculo plurima, axi affixa. *Fructus* globosus, calyce persistente coronatus : *pericarpium* crasso-coriaceum, 4-loculare, dissepimentis mox evanidis ; *semina* plurima, vaga, compresse ovata aut oblonga, in *pulpam* pannosam fibrillis interspersam immersa ; *testa* lævis, pallide brunnea ; chartacea, *embryo* exalbuminosus, elongato-oblongus, mesopodus, sæpe intra pericarpium germinans.

Arbores *frondosæ in India et Malacca indigenæ, rarius suffruticosæ :* folia *sæpe majuscula, oblonga vel orbiculata, serrata, petiolata :* racemi *terminales aut laterales subspicati ;* flores *speciosi, sessiles, imo sæpius 2-bracteati.*

1. CAREYA HERBACEA, Roxb. Pl. Corom. iii. 13, tab. 217 ; Fl. Ind. ii. 638 ; DC. iii. 295 ; W. & A. Prodr. Fl. Pen. i. 335 ; Wight, Icon. t. 557 ; Griffith, Proc. Linn. Soc. i. 280; Notul. pars iv. (excl. descr. pl. p. 660), tab. 634, cuj. figuræ 6 sistent (reliq. excl.); Miq. Flor. Ned. Ind. i. 494. In Ind. Or. : *v. s. in hb. Mus. Brit.* Nepal (*Buchanan*).

A small half-herbaceous shrub, growing in the interior of Bengal and extending into Nepal. It has a ligneous perennial root, which throws out several short perishable branches. Its leaves are 4–8 in. long, $1\frac{1}{4}$–$2\frac{1}{2}$ in. broad, cuneately obovate, acute at the apex, serrulate, smooth on both sides, on a petiole 4 lines long. It has short axillary racemes, bearing a few beautiful flowers, almost sessile, within 2 lanceolate bracts, which embrace the calyx ; the calycine limb is 7 lines long, cup-shaped at the base, and divided halfway into 4 roundish lobes, which are distinct in the bud ; the oblong pink petals are $1\frac{1}{8}$ in. long, $\frac{5}{8}$ in. broad ; filaments closely many-seried, all agglutinated to the monadelphous tube, and falling off with the petals attached to its base, the exterior series bearing no anthers ; ovary 4-celled, with 3 or 4 ovules in each cell. Fruit globular, less than an inch in diameter, crowned by the persistent calyx, without any visible dissepiments, and filled with a greenish pulp, in which the seeds are enveloped ; the seeds are oblong, compressed, 3 lines long, with a homogenous embryo, which often germinates within the fruit.

The description of Griffith, under the head of *C. herbacea*, by a mistake of the Editor, belongs to some *Anacardiaceous* plant. See my remarks under *Doxomma pendulum* (page 100).

2. Careya arborea, Roxb. Pl. Corom. iii. p. 14, tab. 218; Fl. Ind. iii. p. 638; Ham. Trans. Linn. Soc. xv. p. 97; Rheede, Hort. Malab. iii. p. 35, tab. 36; DC. Prodr. iii. 295; W. & A. Prodr. i. 334; Wight, Illustr. p. 20, tab. 99, 100; Miq. Fl. Ned. Ind. i. 494: *Careya sphærica*, Wight, in parte (non Roxb.), Icon. tab. 556. In Ind. Orient.: *v. pl. s. in herb. Mus. Brit.* E. Ind. (*König*), ibidem (*Buchanan*); *in herb. Hook.* E. Ind. (*Carey*), Sikkim (*Hook. et Th.*), Afghanistan ad Kala Nudde (*Ritchie* 362).

A tree, sometimes of immense size, inhabiting the valleys in Orissa and other provinces of India, with many spreading branches sulcately angular, often covered with the cicatrices of fallen leaves. The broadly ovate leaves are suddenly constricted at the apex by a sharp point, are cuneate below the middle, the margins with small close teeth, subflaccid, pale green and opaque above, with about 16 pairs of slender prominulent nerves and a flat midrib, paler beneath, with straw-coloured prominent nerves; they are 7–8 in. long, $3\frac{3}{4}$–$4\frac{1}{4}$ in. broad, on a channelled margined petiole 2–3 lines long. The raceme is terminal, 6–8 in. long, bearing about 3 flowers at the extremity of its stout rachis, which are almost sessile, with 3 bracts at their base; the calyx is tubular, 10 lines long, 5 lines broad, its margin being divided into 4 valvate acute lobes or sepals 3 lines long; the petals are 12–15 lines long, 5 lines broad, with their margins laterally turned back; the stamens are of various lengths, in many series, the longer and shorter series barren, the intermediate series antheriferous; they are all agglutinated at their base into an erect tube, seated on the outer margin of the disk, and to which the claws of the petals are also affixed. The globular drupe is 2 in. in diam., with a smooth fleshy fibrous pericarp 1 line thick; seeds ovate or oblong, compressed, scattered through a ráther solid pulp. The fetid wood is useful, of a reddish colour, with a grain not so close nor so hard as mahogany; and strong ropes are made from the fibres of its bark.

3. Careya sphærica, Roxb. Fl. Ind. iii. 336; Wight, Icon. (ex Roxb.), tab. 147 (non 556); Miq. Fl. Ned. Ind. i. 494. In Malacca, Khasya, et Sikkim: *v. s. in herb. Hook.* Chittagong (*Wall. Cat.* 3640), Kumaon (*Strachey*), Sikkim (*Hook. et Th.*), Mergui (*Griffith*).

A tree 30 feet high, with a trunk 12 feet long, 8 in. in diam., growing beyond the limits of the Indian peninsula. It yields a bark with strong fibres. It differs from *C. arborea* in its larger, broader, more rounded leaves, in its much longer racemes with a thicker rachis, in its more numerous, crowded, larger sessile flowers, bibracteolated at their base. Its branches have a smooth ashy bark, with leaves approximated on their summits. Leaves oblong-ovate, broad, rounded towards the apex, with a short abrupt acumen, suddenly and broadly cuneated towards the base, the margins being minutely crenulate-dentate; they are subcoriaceous, lucid above, with about 20 pairs of patently divaricated nerves conjoined near the margin; they are 9–12 in. long, $4\frac{1}{2}$–$6\frac{3}{4}$ in. broad, on a petiole 4–6 lines long. The racemes are terminal, several inches long, bearing near their summit 6–12 approximated sessile flowers, each supported by 3 basal rounded bractlets 3 lines long and broad; the ovary, 5 lines long, is surmounted by 4 nearly

erect rounded sepals; the 4 petals subacutely oblong, $1\frac{1}{2}$ in. long, 4 lines broad, have the margins rolled back, and are of a palish green colour; ovary 4-celled, with numerous ovules in each cell. Drupe globular, nearly 2 in. in diam., crowned by the calycine lobes; the pericarp and pulp, of a yellowish colour, contain few seeds compressed oblong, about 5 lines long, constructed like those of *C. arborea.* The specific name is not derived from the shape of its leaves, but from the spherical head of large flowers approximated at the extremity of the rachis. Miquel suggests that the species, so well described and figured by Roxburgh, should be expelled from the genus; but as he never saw the plant, and offers no reason for his suggestion, it cannot be admitted. The analysis of this species is shown in Plate XVI. fig. 9 *et seq.*

4. Careya orbiculata, nob.: ramulis lævibus aut rugulosis, cortice crasso: foliis orbiculatis apice rotundatis et obsolete emarginatis, imo subito breviter cuneatim constrictis, ad marginem planum inæqualiter grosse crenatis, dentibus brevissimis obtusis, chartaceis, supra ex brunnescente viridibus, sublucentibus, nervis paucis divergentibus tenuibus paullo prominulis, subtus brunneis, opacis, nervis flavidis venisque reticulatis prominentibus; petiolo plano, compresso, marginato, limbo 20plo breviore: racemo terminali, brevissimo, rachi angulato-sulcata pauciflora; floribus approximatis, sessilibus; calycis limbo cupuliformi fere ad basin in sepala 4 rotundata carnosa diviso, extus pruinoso vel rufo-tomentello; petalis 4, obovato-oblongis, calycis 5pla longitudine, medio crassiusculis, marginibus late submembranaceis, extus flavide pruinosis; staminibus pluriseriatis imo in tubum disco insitum monadelphis, filamentis granulato-rugulosis; disco annulari, plano, margine externo tubum staminiferum gerente, intus in prominentiam tenuem erectam verticem ambientem expanso; ovario infero, tetragono, profunde transverse corrugulato et fere tuberculoso, 4-loculari, ovulis numerosis in axe undique collateraliter affixis. In regno Burmensi et penins. Malayensi: *v. s. in hb. Hook.* Mergui (*Griffith*), Ind., Or. (*Carey*); *fruct. non vidi.*

The stout branchlets of this species are $\frac{1}{4}$ in. thick, closely studded with small cicatrices of fallen leaves; the leaves are $5–5\frac{1}{4}$ in. long, $4\frac{1}{4}–4\frac{1}{2}$ in. broad, on petioles 3–4 lines long: the fragment of the rachis of the terminal raceme is only $\frac{1}{2}$ in. long, marked by the nodes where 4 flowers were affixed; the flowers are loose; the rugous 4-angular ovary 4–5 lines long; the superior limb of the calyx is divided into 4 rounded sepals 4 lines long and broad; the petals 15 lines long, 8 lines broad; the filaments, of equal length, are granulated and conjoined at their base into a tube, to which the petals are also attached by their claws. This species is shown in Plate XVI. fig. 6.

7. Doxomma

is a new genus[1], distinguished from all the preceding by well-marked characters. Its species are lofty trees, with rather large, oblong, cuneated leaves, often upon unusually long petioles. The inflorescence is a very long spike of large handsome flowers, often much approximated and sessile, sometimes bracteolated, upon a stout fleshy rachis

[1] So named from δόξα (*gloria*), ὄμμα (*adspectus*), because of its splendid flowers.

which is erect or more frequently drooping from its great weight; the calycine limb is shortly cup-shaped, and divided nearly to its base into 4 rounded ciliated sepals, imbricated in the bud; the disk as in the other genera; the stamens are monadelphous, upon an erect tubular ring, which is seated on the outer margin of the disk; the filaments, long and slender, coiled in æstivation, afterwards spreading in many series, are all fertile, with small yellow 2-celled anthers; the petals are large and oblong; the style, as long as the stamens, is subulate, terete, with a minute clavate stigma; the inferior turbinate ovary, often 4-winged, is 4-locular, with 2 ovules in each cell, suspended from the summit by thickish funicles. The fruit is cylindrically oblong, furnished with 4 equal longitudinal undulating wings; the pericarp is coriaceous and fibrous, by abortion 1-celled, with a single suspended seed, which fills its cavity; this is covered by a thin coriaceous testa, somewhat adhering to the pericarp; the enclosed embryo is white, nearly as hard as ivory, homogeneous, consisting of two layers, separable by a stratum of tissue (the medullary sheath) which in drying becomes black and pruinose; the outer layer or exorhiza splits at each end longitudinally for some length into four equal divisions, thus leaving both ends of the enclosed inner layer (the neorhiza) somewhat exposed. The embryo, as thus described, is shown in Plate VII. figs. 3, 4, 5, taken from Loureiro's own specimen, now preserved in the British Museum, of his *Eugenia acutangula* (non Linn.). Its structure is evidently analogous to that of the embryo in *Agasta*, *Butonica*, *Stravadium*, and *Careya*, only more pronounced and better corresponding with Gaertner's plate 101 and with Dr. Thomson's instructive observations. To this genus I have referred the *Careya macrostachya* of Jack, and the *Careya pendula* of Griffith.

Doxomma, nob.

Calycis adnati *limbus* breviter cupuliformis, margine in sepala divisus; *sepala* 4, æqualia, rotundata, subcoriacea, ætivatione subimbricata, persistentia. *Petala* 4, oblonga, calyce longiora, crassiuscula, marginibus membranaceis retroflexis, unguibus tubo staminigero agglutinatis et cum illo caduca. *Stamina* numerosissima, multiseriata, imo in tubum subbrevem cylindricum monadelpha, seriebus interioribus sæpe brevioribus, setiformibus, et anantheris. *Stylus* illis æquilongus, tenuiter subulatus, paullo curvatus. *Stigma* simplex. *Discus* plane annularis, margine exteriore tubum staminigerum sustinens, intus in prominentiam erectam ore lato expansus. *Ovarium* inferum, turbinatum, tetragonum, 4-loculare, vertice intra discum concavum; *ovula* in quoque loculo 2, ab apice funiculis suspensa. *Fructus* cylindrice oblongus, subtetragonus, angulis costatis aut anguste alatis, unilocularis, monospermus; *pericarpium* subcrassum, fibroso-coriaceum, calyce coronatum: *Semen* loculum implens, funiculo suspensum; *testa* tenuiter coriacea, pericarpio subadhærens: *embryo* conformis, homoneus, dure eburneus, mesopodus, *exorhiza* a neorhiza soluta, ad utramque extremitatem 4-fissa et hiante, intus pulvere nigro tecta, *neorhiza* in germinatione,ut in *Butonica*, utrinque propullante.

§ 1. *Petioli elongati.*

1. Doxomma pendulum, nob.: *Careya pendula*, Griffith, Notulæ, pars iv. p. 661, tab. 634 A. fig. 1 ad 10 select.: arbuscula, ramulis subtenuibus, lævibus, rubidulis: foliis in apice ramulorum confertis, longe lanceolatis, utrinque valde acutis, marginibus cartilagineis subrevolutis obsoletissime serratis, chartaceis, supra pallide viridibus, opacis, nervis tenuibus patentim divaricatis marginem versus nexis

prominulis valde reticulatis, subtus paullo pallidioribus, costa striata valde prominente, nervis stramineis prominentibus; petiolo tereti, imo crassiore, limbo 8plo breviore: racemo terminali, multifloro, nutante; rachi valida, imo crassiore, angulato-sulcata, colorata; floribus majusculis, subapproximatis, subsessilibus vel brevissime pedicellatis, bracteolis minutis subulatis imo donatis; calyce cupulari, fere ad basin in lobos 4 subimbricatos rotundatos coriaceos marginibus membranaceis ciliato-denticulatis diviso; petalis 4, expansis, crassiusculis, profunde rubris, elongato-ovatis, calycis 3pla longitudine, marginibus revolutis, unguibus ad tubum staminigerum affixis et cum illo caducis; staminibus numerosissimis, albis, quam petala longioribus, pluriseriatis, interioribus sterilibus; disco annulato, margine exteriore tubum staminiferum erectum fulciente, intus in urceolum verticem ovarii concavum cingentem producto; ovario subcylindrico, tetragono, ovulis 3 in quoque loculo funiculis brevibus suspensis: fructu (vix maturo) cylindrice oblongo, apice subconstricto et calyce coronato, subtetragono, lævi, rubidulo, pericarpio crasso, abortu 1-loculari et monospermo; semine ovato, cum ovulis abortivis pendulo, raphe lineari cum funiculo crassiusculo continua, testa reticulata, imo chalaza signato. In regione Malayana et Borneo: *v. s. in hb. Hook.* Mergui (*Griffith*), Mergui (*Parish* cum icone), Sarawak (*Beccari* 3255).

A low tree, growing in woods on hill-sides. A good floral analysis is given both by Griffith and Parish. The branchlets are $\frac{5}{8}$ in. thick; the leaves are 11–14 in. long, $2\frac{1}{2}$–3 in. broad, on petioles $1\frac{1}{4}$–$1\frac{3}{4}$ in. long, with about 15 pairs of nerves, and others shorter and intermediate. The raceme is $2\frac{1}{2}$ feet long, with a stout sulcated rachis 3–5 lines thick; flowers $\frac{1}{4}$–$\frac{1}{2}$ in. apart; calycine lobes $\frac{1}{2}$ in. long and broad; petals $1\frac{1}{2}$ in. long, $\frac{1}{2}$ in. broad; stamens 2 in. long; fruit $2\frac{3}{4}$ in. long, 11 lines broad; seed $\frac{3}{4}$ in. long, $\frac{1}{2}$ in. broad. Griffith, in p. 662, refers to a drawing of this in his tab. 634 A; but there we find a jumble of figures, without numbers, belonging to *Careya* and *Cornus*, 15 figures belonging to the former, the remainder to the latter genus. Of the former I take ten to represent the seed of this species, the two top figures on the left hand showing them in their natural size as above described; another figure shows it magnified to double that size; and seven others exhibit the same, with the embryo before and after it commences germination, showing at the plumular end a curving subulate shoot, furnished at its base with imbricating scales. The five larger figures before mentioned seem to belong to his *Barringtonia conoidea*, for which there was no room in his Plate 615. This intermixture of figures without explanation is attributable to the editor of Griffith's 'Notulæ.' A drawing of this species (with its analyses) is shown in Plate XV. fig. 9 *et seq.*

2. Doxomma cylindrostachya, nob.: *Barringtonia cylindrostachya*, Griffith, Notulæ, part iv. p. 655: ramulis crassis, striatis, opacis: foliis subsparsis, longissime petiolatis, lanceolatis vel lanceolato-oblongis, apice breviter acuminatis, imo cuneatis, margine cartilagineo subrevoluto obsoletissime serratis, chartaceis, supra pallide viridibus, opacis, ad nervos sulcatis, nervis plurimis patenti-divaricatis, intra marginem nexis, transversim reticulatis, subtus flavidioribus, opacis, nervis valde prominentibus, costa prominente; petiolo tereti, striolato, pallide brunneo, imo

valde incrassato, limbo 4plo breviore: racemo terminali, folio subæquilongo; rachi crassa, cylindrica, densiflora, e floribus caducis creberrime cicatricata; floribus sessilibus; calyce pocilliformi crassiusculo, extus brevissime puberulo, fere ad basin in lobos 4 rotundatos diviso; petalis 4, obovatis, crassiusculis, calyce triplo longioribus; staminibus pluriseriatis, imo in tubulum longiusculum monadelphis: disco annulato, margine externo tubum staminigerum fulciente, intus in prominentiam erectam crenulatam verticem concavum cingentem producto; ovario turbinato, acute tetragono, angulis costatis, subcorrugulato, 4-loculari, ovulis in quoque loculo 4–5, axi affixis. In Birma: *v. s. in hb. Hook.* prope Avam (*Griffith* 2421), Malaya (*Maingay* 763).

This differs from the preceding species in its much longer petioles, and racemes with more crowded flowers: the axils of the leaves are $\frac{1}{2}$–$\frac{3}{4}$ in. apart; the leaves are 7$\frac{3}{4}$–14 in. long, 2$\frac{3}{4}$–3$\frac{1}{2}$ in. broad, on a petiole 1$\frac{1}{2}$–2$\frac{1}{2}$ in. long, and with about 30 pairs of nerves; the raceme is 1 foot long, or longer; the rachis 3 lines thick, dark lilac, closely beset with smallish cicatrices of the fallen flowers; the ovary is 4 lines long; the calyx 3 lines, the petals 9 lines long, 4 lines broad; the stamens about 2 inches long; the style 3 in. long, of a deep red colour: 4 or 5 ovules in each cell, upper ones ascending, the lower subpendulous.

3. Doxomma cochinchinense, nob.: *Eugenia acutangula*, Lour. (non Linn.) Coch. i. 375 (excl. synon.): *Stravadium cochinchinense*, Bl. in V. Houtte, Flor. Serr. vii. p. 24: arbor, ramulis patentibus, fistulosis, brunneis, angulato-sulcatis, apice confertim foliiferis: foliis lanceolato-oblongis, apice in acumen angustum obtusulum constrictis, imo acute cuneatis, ad margines cartilagineos revolutos repandos obsolete serratis, subcoriaceis, supra pallidissime viridibus, nervis patentim divaricatis juxta marginem nexis prominulis, valde reticulatis, subtus ochraceo-flavescentibus, valde opacis, nervis venisque prominentibus; petiolo longissimo, limbi fere longitudine, tereti, pallide opaco: racemo (sec. cl. Lour.) longissimo, pendulo, simplici; sepalis 4, rotundatis; petalis 4, subparvis, subrotundis, concavis, conniventibus; ovario infero, rotunde turbinato: fructu cylindrice oblongo, utrinque subacuto, calyce coronato, tetragono, angulis acutis; pericarpio corticoso, subrugoso, flavide fusco; semine unico, magno, oblongo (farinulento dum vivo?), demum durissimo. In Cochinchina, in sylvis: *v. pl. s. in hb. Mus. Brit.* loc. cit. (*Loureiro*, specim. typ.); *v. fruct. in Mus. Brit.* (*Loureiro*).

From the typical specimen and fruit, this species may now be distinguished from the many heterogeneous plants erroneously referred to it. Although Loureiro recorded it as the *Eugenia acutangula* of Linnæus, he was aware of its nearer affinity to the *Butonica rubra* of Rumphius. He described it as a large tree with spreading branches. Its leaves are 4–10 in. long, 2–2$\frac{3}{4}$ in. broad, on petioles 3–7 in. long; they have about 14 pairs of patent fine nerves; the terminal raceme is often 2 feet long. The size of the flowers is not given; but the petals are stated to be small. The typical specimen of the fruit is 3 in. long, 1$\frac{1}{4}$ in. broad, on a short stout pedicel; it is narrowed at each extremity, 4 lines broad at the throat, where it is crowned by the calycine limb 3 lines long. Its shape is somewhat fusiform and striolated, with 4 longitudinal wings, 1$\frac{1}{4}$ line broad, and

wavy on the margin; the pericarp is fibrous, 1 line thick, and contains a single suspended seed, which fills the cell, and which has been fully described in the generic diagnosis (*ante* p. 99). A drawing of the leaf and of the carpical structure of this species is shown in Tab. XVI.

4. DOXOMMA ACUMINATUM, nob.: *Stravadium acuminatum*, Bl. in Van Houtte, Flor. Serr. vii. p. 24; Wall. Cat. 3636: *Barringtonia* (*Careya*) *rosea*, Wall. Cat. 3636: *Barringtonia acuminata*, Korth. in Kruidk. Ned. Ind. Archip. p. 206; Miq. Fl. Ned. Ind. i. 490: foliis lanceolatis vel oblongo-lanceolatis, apice in acumen breve attenuatis, imo sensim acutis, marginibus tenuiter cartilagineis, obsoletissime serratis, tenuiter chartaceis, supra pallide viridibus, opacis, nervis tenuissimis, divaricatis, reticulatis, subtus concoloribus aut paullo pallidioribus, nervis venisque prominulis, costa tenui, striolata; petiolo tenuissimo, semitereti, imo gibbose incrassato, limbo 6plo breviore: racemis spicatifloris; rachi cylindrica, valida, sub medium e floribus caducis crebre cicatricata; floribus subparvis, subapproximatis, sessilibus; calycis limbo cupuliformi, coriaceo, ad basin in sepala 4 diviso, sepalis ferrugineo-pruinosis; petalis 4, roseis, calyce paullo longioribus; staminibus numerosissimis, imo in tubum monadelphis; disco annulari, margine externo tubum staminiferum fulciente, intus in prominentiam fornicatam verticem concavum ambiente producto; ovario quadratim turbinato, ferrugineo-pruinoso, angulis cum lobis calycinis alternis, alatis, subcrenatis, 4-loculari, ovulis 3–4 in quoque loculo suspensis: fructu elongato-ellipsoideo, utrinque obtuso, lævi, subtetragono. In Malacca et Borneo: *v. s. in hb. Soc. Linn.* Chappadong in ripis (*Wall. Cat.* 3636); *fruct. non vidi.*

Wallich's specimen from the province of Martaban agrees with Blume's diagnosis of a plant first mentioned, by name only, by Korthals, and to which he assigned the locality of Borneo. Wallich at first gave it the name of *Barringtonia* (*Careya*) *rosea*, but afterwards changed it to *Barringtonia acuminata*, considering it to be the same as Korthals's, perhaps; and if so, its range must be considerable. In Wallich's specimens the leaves are $5\frac{1}{2}$–8 in. long, $1\frac{1}{2}$–$2\frac{1}{4}$ in. broad, on petioles 1–2 in. long; Blume gives the dimensions as $3\frac{1}{2}$–11 in. long, $1\frac{2}{3}$–$3\frac{1}{2}$ in. broad, on petioles $\frac{3}{4}$–$2\frac{1}{2}$ in. long, from a plant collected by Korthals in the woods of Pamattan, in Borneo. The raceme in Wallich's specimen is above 9 in. long, 3 lines thick, straight; the sepals are 2 lines long, 3 lines broad; the 4 angles of the ovary are winged and undulately crenated; the inner margin of the disk is acute and elevated, within which the vertex is deeply concave.

5. DOXOMMA SARCOSTACHYS, nob.: *Stravadium Sarcostachys*, Blume, in Van Houtte, Fl. Serr. vii. p. 24: *Barringtonia sarcostachys*, Miq. in Fl. Ned. Ind. 90: foliis lanceolato-oblongis, apice obtusis vel acutis, imo cuneatis, integerrimis, nervosis; petiolo tereti, limbo 4plo breviore: racemo spicato, rachi cylindrica, crassa, carnosa, recta: fructu subtetragono. In ins. Sumatra: *non vidi.*

Blume's short diagnosis is copied by Miquel, who adds, this species is very different from *D. sumatrana*. Both state that the leaves are $4\frac{1}{2}$–10 in. long, $2\frac{3}{4}$–$3\frac{1}{2}$ in. broad, on petioles 1–$2\frac{3}{4}$ or sometimes 3 in. long.

6. DOXOMMA SUMATRANA, nob.: *Barringtonia sumatrana*, Miq. in Fl. Ned. Ind. i. Suppl. p. 315: foliis elliptico-oblongis, apice in acumen obtusulum vel acutum subito constrictis, imo cuneatis, subcoriaceis, crenato-serrulatis, dentibus obtusis, sæpe mucroniformibus, supra lucidis, costa nervisque subpatulis prominulis, subtus nervis parum prominulis; petiolo longiusculo, supra subplano, marginibus acutis: racemo cylindraceo, terminali, erecto: fructu oblongo, acute tetragono, apice sepalis 4 obtuse ovatis coronato, lævi, pallido. In Sumatra: *v. s. in hb. Hook.* Sarawak (*Beccari* 851, 1554).

A species, according to Miquel, distinct from *D. Sarcostachys*, though closely allied to it; the leaves are said to be 3–8½ in. long, 1⅝–2⅝ in. broad, on petioles 2–2¾ in. long: no other particulars are given. I have referred here Beccari's specimen 851, from Sarawak, which agrees well with Miquel's character as to the leaves, but differs in its shorter petioles: here the leaves are elliptic-oblong, with a narrow acumen at its apex near ½ in. long; they are gradually subcuneate to the base, crenately serrulate on the margins, the teeth sometimes nearly obsolete and mucroniform, they are from 2½–10 in. long, 1⅛–2¼ in. broad, on semiterete petioles ¼–1⅛ in. long, with slender patent arcuated nerves; and the rachis is stout, more than 7 in. long (broken off at the summit); the sepals rounded, somewhat acute, smooth, fleshy, entire, 4 lines long and broad, united in a short cup at their base; the petals are obovate, rounded; the ovary is turbinate, rugulose, and sessile. In Beccari's 1554 the leaves are more lanceolate and paler.

7. DOXOMMA NEO-CALEDONICUM, nob.: *Barringtonia neocaledonica*, Vieill. in Proc. Soc. Linn. Normand. viii. p. 10: arbor excelsa, ramis erectis; ramulis subtenuibus, apice crebre foliiferis, inferne foliis delapsis cicatricatis: foliis lanceolato-oblongis, utrinque acutis, ad marginem subrevolutum cartilagineum obsoletissime serratis, supra læte viridibus, nervis tenuibus adscendenti-divaricatis prominulis, valde reticulatis, subtus flavide pallidioribus, glaucescenter opacis, nervis venisque prominentibus; petiolo subtenui, tereti, limbo 15-plo breviore: racemo terminali, pendulo, spicato, rachi cylindrica, crassiuscula, imo compressa, albide glauca, creberrime multiflora; floribus amplis, sessilibus, imo setaceo-bracteolatis; calyce cupuliformi, fere ad basin in sepala 4 ovata obtusa glabra subimbricata diviso, sepalis coriaceis, margine late submembranaceis, ciliato-denticulatis, extus albide scabridulis; petalis 4, oblongo-ovatis, crassis, albide roseis, sepalis 4plo longioribus; staminibus numerosissimis, pluriseriatis, imo in tubum brevem monadelphis, seriebus interioribus sæpe antheris; disco plano, margine exteriore tubum staminigerum fulciente, intus in urceolum latum erectum producto, vertice hinc circa stylum concavo; ovario infero, obconico, ruguloso, alatim tetragono, alis rectis, angustis, 4-loculari, ovulis in quoque loculo 4, suspensis: fructu oblongo, cylindrico, calyce coronato. In Nova Caledonia, in sylvis humilioribus: *v. pl. s. in hb. Hook.* Gatasse, Wagap (*Vieillard* 2630); *fructum non vidi.*

A tall tree, 65–80 feet high, with leaves about ½ in. apart, 8–8½ in. long, 2⅜–2⅝ in. broad, on petioles 6–8 lines long: the raceme is more than 5 in. long, with a cylindrical straight rachis 3 lines thick, studded in many places with close cicatrices of the fallen flowers:

the handsome flowers are rather crowded and sessile; the calycine sepals are 3 lines long; the petals 12 lines long, 9 lines broad. The fruit is said to be 3½ in. long.

8. Doxomma rigidum, nob.: ramulis crassis, sulcato-angulatis, dealbatis: foliis majusculis, lanceolato-oblongis, apice sensim acuminatis, imo gradatim acutis, marginibus subrevolutis fere integris et punctis nigris subremotis signatis, rigide coriaceis, supra intense viridibus, opacis, obsolete corrugulatis, ad costam sulcatis, nervis divaricatis semiimmersis, subtus pallidioribus, costa valida, imo sensim incrassata, striolata, fusca, nervisque fuscis prominentibus, marginem versus nexis, venis transversim reticulatis; petiolo valido, imo crassiore, semitereti, fusco, supra sulcato, subtus striolato, limbo 20plo breviore: racemis axillaribus, fructiferis, superioribus folio subæquilongis, inferioribus multo brevioribus, rachi rigida, subflexuosa, alternatim prominenter nodosa: drupis in nodis sessilibus, quadrato-cylindricis, angulis rotundatis, utrinque subtruncatis, lobis calycinis 4, parvis, erectis, rotundatis, concavis, coronatis; pericarpio in fructu immaturo crasse coriaceo, pallido, extus nitido, intus crasse coriaceo, 4-loculari, loculis 3 subabortivis, uno majore, ovulis plerumque marcescentibus. In Malaya: *v. s. in hb. Hook.* (Maingay 767, 2496).

A peculiar species, with stout branchlets 5 lines thick, and axils ½–¾ in. apart; leaves rigid, 9½–11½ in. long, 3½–3¾ in. broad, on stout rigid curving petioles 1¼–1½ in. long; raceme in the superior axil above 12 in. long, in the lower axils 2–3 in. long, all fructiferous, the flowers having fallen off: the rachis is stout, suberect, angulated, with alternate nodose axils 2–4 lines apart, at first little prominent, but in fruit the nodes are thick and prominent; the fruit, sessile upon them, is, in the immature state, 1 in. long, 4 lines broad.

9. Doxomma macrostachyum, nob.: *Careya macrostachya*, Jack in Calc. Journ. iv. 335; in Hook. Bot. Misc. ii. 88: arbor ramulis lævibus, cinereis: foliis sparsis, obovato- vel oblongo-ovatis, apice obtuso in acumen breve constrictis, imo sensim cuneato-angustatis, tenuiter chartaceis, margine tenui cartilagineo subrevoluto obsolete serrulatis, supra lævibus, læte viridibus, nervis rubellis tenuibus semiimmersis, subtus pallide flaviusculis, costa nervis venisque valde reticulatis prominulis; petiolo subtenui, imo incrassato, supra canaliculato, limbo 5–7plo breviore: racemis dependentibus, rachi crassissima, basi erecta, creberrime multiflora; floribus speciosis, sessilibus, spiraliter enatis, ebracteatis; sepalis 4, rotundatis, glabris, denticulatis, purpurascentibus; petalis 4, triplo longioribus, obtuse ovatis, unguiculatis, rubris; staminibus albis, numerosissimis, imo monadelphis, petalis paullo longioribus; disco plano annulato, margine externo tubum staminigerum fulciente, interno in urceolum elevatum producto, urceolo intus rubro-striato, ore lato integro et flavido, profunde circa stylum ambiente; ovario turbinato, infero, 4-loculari, ovulis 4 in quoque loculo suspensis; fructu (sec. cl. Jack) baccato vel pomiformi. In Penang et Borneo: *v. pl. s. in herb. Hook.* Sarawak (*Beccari* 1535); *fruct. non vidi.*

A tree, with grey bark and smooth branches, found by Jack at Pulo Penang, who

remarks that in its expansive inflorescence, which is very remarkable, it is unlike any known species of *Careya*. I have nowhere met with any plant which agrees with Dr. Jack's description, except that above quoted, found in Borneo by Beccari, the distances between the two places being only 600 miles of intervening sea. Jack's account differs in no respect from Beccari's plant except in the character of his *nectarium*, which is said to be *hypocrateriform*; but this cannot be; it is certainly a mistake, caused by the editor of his notes, in substituting that word for *crateriform*. With this correction, Jack's account admirably conforms with the structure seen in Beccari's plant; we can therefore have little doubt of the specific identity of the two plants. Jack does not give the size of the leaves, though in form both are alike: in Beccari's specimen they are $2\frac{3}{4}$–$5\frac{1}{2}$ in. long, $1\frac{5}{8}$–$3\frac{1}{8}$ in. broad, on slender petioles, thickened at their base, 7–9 lines long. The rachis of the inflorescence, according to Jack, is thick, massive, cylindrical, 8–10 in. long, bearing crowded sessile rather large handsome flowers. In Beccari's specimen the turbinated ovary, 3 lines long, is $1\frac{1}{2}$ line thick at base, 4 lines above; the sepals are 3 lines long and broad; the petals, thick and fleshy, are 10 lines long, 6 lines broad; the stamens, 11 lines long, are seated on a monadelphous tube 1 line long; the elevated expansion of the inner margin of the disk (*nectarium*, Jack) is two lines higher than the disk, but much deeper within and around the style, its entire margin being $2\frac{1}{2}$ lines in diameter: the structure of the ovary is as I have described it. Wallich wrongly referred to this species his *Stravadium angustatum*; Roxburgh was alike in error with respect to his *Barringtonia racemosa*, and Griffith also to his *Careya pendula*, as well as Miquel in regard to his *Stravadium costatum*. All these surmises are without any evidence to support them.

§ 2. *Petioli subbreves.*

10. Doxomma angustatum, nob.: *Stravadium angustatum*, Wall. in Cat. 3637: ramulis crassiusculis, angulato-sulcatis, pallide brunneis, fistulosis: foliis approximatis, lanceolato-oblongis, apice in acumen acutum attenuatis, a medio gradatim cuneatis ad imum angustum subito rotundatis, margine cartilagineo subrevoluto crenatis, et obsoletissime serrulatis, flaccide coriaceis, supra pallidissime glaucis, opacis, nervis tenuibus divaricatis prominulis, reticulatis, subtus fere concoloribus, nervis venisque reticulatis prominentibus, costa striolata paullo prominente; petiolo compresso, latiusculo, supra plano, subtus convexo et striolato, pruinoso, limbo 80–90plo breviore: racemo terminali, stricto, folio multo breviore; rachi cylindrica, undique creberrime florifera; floribus pro genere parvis, sessilibus, bracteolatis; calyce cupuliformi, fere ad basin in sepala rotundata coriacea margine ciliata diviso; petalis 4, sepalis 2plo longioribus, membranaceis; staminibus numerosissimis, imo in tubulum erectum monadelphis; disco annulari, extus tubum staminiferum fulciente, margine interno in prominentiam brevem vertice concavo ambiente producto; ovario infero, quadrato, angulis alis rigide coriaceis crenato-undulatis munito, albide pulverulento, 4-loculari, ovulis 2–4 in quoque loculo suspensis. In Tenasserim: *v. s. in hb. Soc. Linn. et Hook.* Amherst (*Wall. Cat.* 3637 cum not.; an *Careya macrostachya*, Jack?); Tenasserim (*Wall. Cat.* 3637, *Helfors*).

This plant agrees in its general characters with the preceding species, and differs from Jack's plant in its more lanceolate and very pallid leaves, on almost obsolete flat petioles, and its spicated raceme, which is not massive, and its ovary with crenulately undulated wings. The leaves are 9–17 in. long, 3–4¾ in. broad, on petioles 2 lines long, 2 lines broad; the portion of the raceme in the specimen is 6 in. long, 2½ lines thick, closely beset with the rather small cicatrices of the fallen flowers: the calyx is 3 lines long; the ovary of the same length, with broad crenulated winged angles; the petals are 6 lines long, 3 lines broad.

11. Doxomma Vriesii, nob.: *Barringtonia Vriesii*, Teijm. & Benn. Nat. Tijd. Ned. Ind. ii. 308; Kruidk. Arch. iii. 411; Miq. Fl. Ned. Ind. i. 491 et 1087; Walp. Ann. iv. 852: arbor mediocris, ramulis roridis, hepatice viridibus: foliis oblongo-lanceolatis, apice anguste acuminatis, imo cuneatim acutis, marginibus obsolete serrulatis, utrinque glabris, supra lucide viridibus, costa plana; petiolo hepatico, supra plano: racemo terminali, rachi valida, erecta, folio longiore, spicatim densiflora, pedicellis roridis, imo bibracteolatis; petalis speciosis, albido viridulis: fructu majusculo, oblongo, utrinque sensim attenuato, tetragono, hepatice viridi. Java, in prov. Bantam (*non vidi*).

This is said to be a handsome tree, not very high, with wide-spreading branches, growing in moist places: its leaves are 4–5½ in. long, 1½–2 in. broad, with liver-coloured petioles: the raceme is erect, 4–7 in. long, with numerous very handsome approximated flowers, having whitish-green petals, which, with the stamens, fall off in great numbers, and appear like a party-coloured carpet beneath the tree. Miquel, in his diagnosis, which is an exact copy of that of the Dutch authors, by mistake, says "baccæ verrucosæ," not observing the typical error in the original, "drupis verrucibus" for "drupis viridibus," the latter being so described in their annotation. Miquel admits that he never saw the plant, not even a dried specimen of it, nor its fruit. He adds that the genus to which it belongs is doubtful, because of its bibracteolated flowers, and suggests, without any reason, that it may be the *Planchonia Timoriensis*, Bl. But subsequently he again falls into error, stating positively that it is identical with the *Barringtonia excelsa*, Bl.; but this cannot be admitted, because the latter is a very lofty tree, with a remarkable and different inflorescence; and, notwithstanding this, he again suggests that it may be the type of a new genus. I have no doubt that it belongs to *Doxomma*, of which it presents all the characters, especially in its stout erect rachis densely covered with numerous handsome bracteolated flowers. Teijmann and Bennindijn describe the fruit as a little longer than a goose's egg, pointed at both extremities, and liver-coloured.

12. Doxomma magnificum, nob.: ramulis validissimis, summo breviter constrictis et setaceo-ramentosis, dein crassioribus et cicatricibus petiolorum magnis creberrime signatis: foliis majusculis, elongato- et late oblongis, apice in acumen brevissimum obtusum constrictis, sub medium cuneato-angustatis et circa petiolum subito rotundiusculis, in marginibus incrassatis, obsolete serrulatis, subcoriaceis, supra pallidissime viridibus, opacis, nervis remotis arcuatim adscendentibus tenuibus vix prominulis,

reticulatis, costa valida, imo sensim crassiore, subtus palidissime lutescentibus, nervis costatis, venis prominulis, costa convexa, valde prominente; petiolo latissimo semitereti, limbo 30plo breviore: racemo terminali, longissimo, mox pendulo; rachi cylindrica, crassissima, profunde striata, subcrebriflora; floribus in paribus superpositis et sessilibus, imo bractea majuscula lanceolata decidua munitis; calyce cupuliformi, fere ad basin in lobos 4 imbricato-oblongos concavos carnosulos diviso, extus brevissime puberulo; petalis 4, oblongis, marginibus late revolutis, calyce 3plo longioribus, viridi-albidis, expansis; staminibus numerosissimis, imo in tubulum erectum monadelphis et cum petalis imo agglutinatis simul caducis; disco annulato, margine externo tubum staminigerum fulciente, intus in prominentiam elevatam styli basin cingentem producto; ovario subcylindrico, tetragono, obsolete puberulo, 4-loculari: fructu immaturo subparvo oblongo-ovato, utrinque obtuso, calyce coronato, quadrato, angulis subalatis, abortu 1-loculari et monospermo. In Tenasserim: *v. s. in hb. Hook.* Tavoy (*Parish*).

A tree 30–40 feet high, with a straight trunk and a fine head of spreading branches, called by the natives *kyai-gyce*; it is also found at Moulmein. It forms a species quite distinct from most of the preceding, differing in its much broader leaves, on short petioles, and in its flowers arranged in pairs, and its fruit with winged margins. Its leaves, very crowded at the extremity of the branches, are 16 in. long, 6 in. broad, on a petiole 6 lines long, 4½ lines broad, with about 13 pairs of very spreading nerves; raceme upwards of 3 feet long, rachis 6 lines thick below; pedicels 1 line long; calyx 4 lines long; petals 10 lines long, 6 lines broad; stamens above an inch long; fruit (perhaps immature) 11 lines long, 8 lines broad, quadrate, with winged margins, its single seed is suspended, 5 lines long.

8. Petersia.

This is a singular genus, proposed by Dr. Welwitsch for a plant discovered by him in Angola, a tree of large size, with an expanded comose head: it has terminal pendent racemes, on a rather thin rachis, bearing many small flowers, each upon a long slender pedicel, which is bibracteolated in the middle; the calycine limb consists of 4 small rounded erect sepals, distinct in the bud; 4 obtuse petals, fixed by their claws to the staminiferous tube; an inferior turbinate 4-winged ovary, which is 4-locular, with several ovules suspended in the summit of each cell; the fruit is of a narrow linear cylindrical shape, coarsely hispid, with 4 very large extremely broad membranaceous wings. By abortion it is unilocular, with few linear compressed suspended seeds.

Petersia, Welwitsch.

Calycis adnati *limbus* in sepala divisus. *Sepala* 4, rotundata, erecta, ciliata, in æstivatione subimbricata, persistentia. *Petala* 4, cuneato-oblonga, membranacea, calyce longiora, unguibus ad tubum staminigerum affixa, et cum illo caduca. *Stamina* numerosissima, multiseriata, imo in tubum brevem cylindricum monadelpha: *filamenta* tenuia crispatim flexuosa; *discus* anguste annularis, externe tubum staminigerum fulciens, interne in urceolum brevem productus; *stylus* tenuis, longitudine staminum; *stigma* parvum, clavatum. *Ovarium* inferum lineari-turbinatum, 4-alatum, alis imo obsolete 4-lobatis in pedicellum deliquescentibus, apice rotundatis, sepalis alternis, 4-loculare: *ovula* in

quoque loculo plurima, axi summo suspensa. *Fructus* lineari-cylindricus, latissime 4-alatus, *alis* magnis, latissimis, apice profunde semicordatis, membranaceis, crebre parallele et horizontaliter nervosis; *pericarpium* lineare, tenuiter fibroso-coriaceum, abortu 1-loculare; *semina* pauca, lineari-oblonga, compressa, subimbricatim ab apice suspensa.

Arbor *Angolensis, grandis, frondosa:* folia *alterna, elliptico-oblonga, utrinque acuta, breviter petiolata;* racemus *terminalis, brevis, pauciflorus;* flores *alternatim pedicellati, inconspicui;* fructus *singulariter late 4-alatus, majusculus.*

Petersia africana, Welwitsch, Hook. & Benth. Gen. Pl. i. 721; Oliv. Fl. Afr. Trop. ii. p. 439: procera, coma magna dilatata, apice depressa, ramis dependentibus: foliis epunctatis, oblongo-ellipticis, apice in acumen acutum subito constrictis, imo sensim cuneatis, marginibus obsoletissime serratis, subcoriaceis, supra sublucidis, intense viridibus, nervis tenuibus divaricatis marginem versus nexis vix prominulis, subtus pallidioribus, opacis, nervis prominulis in axillis barbatis; petiolo tereti, marginato, limbo 12plo breviore: racemis in ramulis novellis terminalibus aut subaxillaribus, folio brevioribus, paucifloris; floribus subparvis, longe pedicellatis; pedicellis tenuibus, elongatis, medio bibracteolatis, bracteolis parvis, lanceolatis, oppositis, puberulis; calycis limbo in sepala 4 semiovata erecta puberula ciliata diviso; petalis 4, rotundo-oblongis, glabris, unguibus tubo staminigero agglutinatis; staminibus numerosissimis, petalis longioribus, imo in tubum brevem erectum monadelphis; ovario infero, turbinato, 4-alato, alis latiusculis, ciliatis, 4-loculari, ovulis in quoque loculo plurimis, pluriseriatis, axi centrali affixis: fructu lineari, tetragono, latissime 4-alato, alis membranaceis, glabris, parallele nervosis, superne profunde cordatis; pericarpio extus setis rigidis hispido, textura fibroso; endocarpio tenuiter coriaceo, aborto 1-loculari, axi e loculis abortivis hinc parietali; seminibus 4–5, linearibus, compressis, imbricatis, funiculis ab apice suspensis. In Africa occidentali, in convallibus humidioribus Monte de Quetecati, distr. Cal. alto, regno Angolensi: *v. s. in hb. Hook.* (*Welwitsch*).

An immense tree, 50 feet high, its trunk 4 feet in diameter to a height of 20 feet, when it throws out many spreading and somewhat pendent branches, forming a head rather depressed at its summit. The leaves are $3\frac{1}{2}$–$6\frac{1}{2}$ in. long, $1\frac{1}{2}$–$2\frac{1}{2}$ in. broad, on petioles 3–6 lines long, having 12–14 pairs of nerves, with a tuft of hairs at their origin: it is stated (Hook. & Benth. Gen. Plant. i. p. 721) that its leaves are pellucidly punctate. I contested this point with the late Dr. Welwitsch, showing him that in all the younger leaves, and in nine cases out of ten, no pellucid dots are visible, and that where they were present, this was due to round globules of transparent matter deposited by insects in the parenchyma, sometimes in clefts made by them, sometimes appearing like raised glands. The terminal raceme is 3 in. long, on a rather slender rachis; the pedicels are 6–9 lines long, bearing in their middle (where they are articulated) 2 opposite lanceolate bracts $1\frac{1}{2}$ line long; the ovary is 2 lines long, is broadly 4-winged; the sepals 1 line long; the petals 4 lines long, 2 lines broad; the stamens 5 lines long; the style 6 lines long. The fruit is altogether $2\frac{3}{4}$ in. long, $2\frac{1}{2}$ in. broad, the wings deeply cordate at the summit; the central pericarpial portion begins at the deep sinus between the wings, extending down-

wards to the base; this portion is almost spinosely hirsute exteriorly: its texture consists of loose rigid longitudinal fibres without any agglutination; and, by abortion, it is only 1-celled, lined with a thinnish coriaceous endocarp, is 12 lines long and 2 lines in diameter; by the abortion of 3 of the cells, the central placental axis becomes parietal; and upon it I observed four or five imbricated seeds, linear and much compressed, $3\frac{1}{2}$ lines long, $\frac{1}{2}$ line broad, suspended from the summit by a broad funicle 2 lines long; the embryo I could not make out. Dr. Welwitsch, in his note, quoted in the 'Genera Plantarum,' states he did not find perfect seeds; but the above details were obtained from a fruit, flowers, and plant kindly given to me by the late Dr. Welwitsch.

A drawing of this species (with its floral and carpological analyses) is shown in Tab. XVIII. figs. 16 to 26.

9. Megadendron *.

This genus is proposed for two handsome Java plants, very lofty trees, one of which is the *Barringtonia macrocarpa*, so well described by Hasskahl in 1844: it has large long leaves, and bears much resemblance in its handsome flowers, upon a long terminal raceme, to those of *Doxomma*; but it differs from that genus in the constantly variable number of its sepals and petals, in the inflected margins of its erect sepals (free even in æstivation), in the position of its ovules, and in its much more elongated fruit.

Megadendron, nob.

Barringtonia, Hassk. et Bl. (non Forst.).

Sepala 2, 3, 4, libera, acute oblonga, chartacea, parallele nervosa, erecta, jam inde in æstivatione marginibus involutis et ad se applicitis, persistentia. *Petala* 4, 5, 6, duplo majora, oblonga, æstivatione imbricata, dein expansa, lateribus retroflexis, unguibus tubo staminigero agglutinata, et cum illo caduca. *Stamina* numerosissima, in tubum brevem imo monadelpha; *filamenta* filiformia, pluriseriata, petalis longiora, seriebus interioribus anantheris et capillaribus; *antheræ* parvæ, 2-loculares. *Discus* epigynus, plane annularis, margine exteriore tubum monadelphum fulciens, interiore in urceolum brevem latum expansus. *Stylus* filiformis, longitudine staminum; *stigma* parvum. *Ovarium* inferum, turbinatum, vertice intra urceolum et stylum concavo, 4-loculare, ovulis in quoque loculo 5–6 (raro 2–4) axi radiatim affixis. *Fructus* majusculus, elongato-cylindricus, utrinque obtusatus, calyce persistente styloque coronatus; *pericarpium* crassum, fibroso-coriaceum, abortu 1-loculare et monospermum. *Semen* loculum implens, cylindricum, utrinque subattenuatum, obsolete tetragonum: *testa* fusca, submembranacea; *embryo* exalbuminosus, amygdalinus, mesopodus, siccus *exorhiza* ad utramque extremitatem in fissuras 4 hiante.

Arbores *Timorenses et Javenses, excelsæ, ramosæ;* folia *majuscula in apicibus ramorum congesta, oblonga vel lanceolata, fere integra, petiolata;* flores *speciosi, in racemo terminali sparse spicati.*

1. Megadendron macrocarpum, nob.: *Barringtonia macrocarpa*, Hassk. Diagn. Nov. p. 504; in Cat. Hort. Bogor. p. 263; in Bot. Zeit. xxvii. 598 (1844); Miq. Fl. Ned. Ind. i. 485 (1855): *Barringtonia racemosa*, var. *elongata*, Bl. in Van Houtte, Fl. Serr. vii. 24: arbor alta, ramis crassis, cinerascentibus: foliis in summo ramulorum crebre congestis, late oblongis, apice acuminatis, infra medium subito cuneatis, ad marginem subrevolutum crenato-serratis, coriaceis, glaberrimis, supra profunde viri-

* A μέγας (*magnus*), δένδρον (*arbor*).

dibus, nervis paullo prominulis, costa plana, imo incrassata, subtus pallidioribus, nervis validis, albescentibus; petiolo brevi, crasso, semitereti, late marginato, atroviridi, limbo 70plo breviore: racemo terminali, pendulo, folio æquilongo; floribus speciosis, sparse spicatis, pedicellatis; sepalis 2, 3, 4, acutis, erectis, marginibus anguste inflexis, chartaceis, parallele nervosis; petalis 4, 5, 6, obovatis, triplo longioribus, lateribus undulato-reflexis, albis; staminibus disco styloque ut in char. gen.; ovario infero, 4-loculari: fructu elongato-cylindrico, structura in char. gen. descripta. In Java et in insulis Sondaicis: *v. s. in hb. Mus. Brit.* Patjetan (*Horsfield*); *in hb. Hook.* Straits Sunda (*Staunton*); *fruct. non vidi.*

A lofty tree, with spreading branches; its leaves are 10–18 in. long, 4–6 in. broad, on stout petioles 2 lines long and broad; raceme more than a foot long, with flowers $\frac{1}{2}$–$\frac{3}{4}$ in. apart, $2\frac{1}{2}$ in. in diam.; pedicels stoutish, nearly $\frac{1}{2}$ in. long; ovary the length of the sepals, which are 4 lines long; petals 9–12 lines long; staminiferous tube $\frac{1}{10}$ in. long; exterior filaments $1\frac{1}{4}$ in. long, interior ones short, capillary without anthers; fruit 5 in. long, $1\frac{1}{4}$ in. broad at the angles, 1 in. broad at the sides; cell of pericarp $2\frac{3}{4}$ in. long; the seed fills the cell. Blume regarded this plant as a variety of *Butonica racemosa*, naming it *elongata*, on account of its very long cylindrical fruit. Hasskahl gave copious and exact characters of this plant, which is almost the only species in the family well described; for Blume and Miquel have given only laconic characters, often contradictory and incomplete. Had they followed the example of Hasskahl, we should have obtained a much better knowledge of the family.

A drawing of this species (with its floral and carpological analyses) is shown in Tab. XV. figs. 1 to 8.

2. Megadendron pallidum, nob.: foliis longe lanceolatis, apice sensim acuminatis, imo gradatim longe cuneatis, subsessilibus, sinuato-serratis vel marginibus subrevolutis, hinc punctis nigris remotis signatis, subcoriaceis, supra pallidissimis, nervis remotis subrecto-divergentibus marginem versus nexis, costa plana, immersa, imo gradatim valde incrassata, subtus fere concoloribus, costa nervisque prominentibus; petiolo vix ullo: racemo terminali, pendulo, rachi subtenui, compresse striata; floribus subsparsis, brevissime pedicellatis; sepalis 2–3, acutis, rectis, concavis, marginibus anguste involutis (petalis et staminibus lapsis); ovario infero, oblongo, obsolete tetragono, superne disci urceolo stylum ambiente notato, 4-loculari, loculis 3 cum ovulis abortivis, in altero ovulo magno pendulo. In Java: *v. s. in. hb. Mus. Brit.* loc. cit. (*Horsfield*).

A species evidently belonging to this genus: its leaves are $19\frac{1}{2}$ in. long, $4\frac{5}{8}$ in. broad, quite sessile; the rachis of the raceme is not very stout, 15 in. long; pedicels 3–6 lines apart, less than 1 line long; ovary grown after the fall of the petals is $\frac{3}{4}$ in. long, crowned by 2, sometimes 3 sepals 5 lines long, $2\frac{1}{2}$–3 lines broad at the base.

3. Megadendron? ambiguum, nob.: *Barringtonia timorensis*, Blume in Van Houtte, Flor. Serr. vii. p. 25; Miq. in Fl. Ind. Ned. i. p. 485: foliis oblongis vel elliptico-oblongis, apice acutis aut acuminatis, infra medium subcuneatis, basi subacutis

vel obtusis, obsolete serrulatis, nervis tenuibus, remotiusculis; petiolo limbo 30–40plo breviore: racemo terminali, spicatifloro, longissimo, rachi crassiuscula, erecta, vel subnutante, glabra; floribus ignotis: fructu ovoideo, acute tetragono. In ins. Timor: *non vidi.*

A species ambiguous in its relations. Blume places it next to his *Barringtonia racemosa,* which is numerous in synonyms, the chief of which is his var. *elongata,* the type of this genus. Miquel's description of this species is a mere repetition of Blume's unsatisfactory diagnosis. It appears to me to belong to *Megadendron,* not only on account of the country of its origin, but its general habit, its long pointed cuneated leaves, suddenly rounded at base upon an extremely short petiole, a terminal long raceme, with an erect thickened rachis—characters peculiar to the genus to which I have assigned it. Blume and Miquel refer it to the *Barringtonia acutangula,* Spanaghoe, a species known by name only, without any given character, and evidently unknown to them. Blume states that the leaves in this species are 4–10 in. long, $1\frac{1}{2}$–$4\frac{1}{4}$ in. broad, on petioles only 2–3 lines long. No other dimensions are given.

10. Chydenanthus.

This new genus[1] is founded upon a plant which differs from all others of the family in having a branching paniculated inflorescence, and which was originally described by Blume in 1826 under the name of *Barringtonia* or *Stravadium excelsum.* It is a native of Java, a lofty tree, with broadly spreading branches and long pointed leaves; the terminating panicle, longer than its large leaves, has alternate branches, presenting at rather short intervals alternate very prominent nodes, each having articulated upon it a sessile ebracteated flower of moderate size: the calyx is peculiar, of a cup-shaped form, with an almost entire margin, broadly open in the bud; it has 4 oblong petals, attached by their claws to the staminiferous tube as in the other genera; there is a peculiarity in the stamens in having most of the filaments antheriferous, while the 2 or 3 inner rows are reduced to the form of slender barren pointed hairs: the inferior ovary is cylindrical, 8-grooved, 2-locular, with a single ovule erect in each cell: the fruit, according to Blume, is like that of *Stravadium* in form.

Chydenanthus, nob.

Stravadium, Bl.; *Barringtonia,* Miq.

Calycis adnati *limbus* hemisphærice cupuliformis, margine truncatus, vix lobatus, ciliolatus, subcoriaceus, persistens. *Petala* 4, obovata, quorum 2 paullo majora, calyce 4plo longiora, membranacea, unguibus ad tubum staminigerum affixa, et cum illo caduca. *Stamina* numerosissima, multiseriata, imo in tubum cylindricum monadelpha, seriebus exterioribus fertilibus, interioribus multo brevioribus, tenuioribus, ad basin fere liberis, anantheris. *Stylus* tenuis, æquilongus. *Discus* plane annularis, margine externo tubum staminigerum fulciens, intus in prominentiam erectam expansus. *Ovarium* inferum, semiglobosum, 2-loculare: *ovula* in quoque loculo solitaria, erecta. *Fructus* elongato-ellipsoideus, utrinque obtusus, tetragonus: cætera ignota.

Arbor *Javensis procera, frondosa*; folia *lanceolato-oblonga, utrinque acuta, subobsolete serrata, breviter*

[1] From χύδην (*diffuse*), ἄνθος (*flos*).

petiolata; inflorescentia *terminalis vel subaxillaris, singulariter paniculata, rachi pubescente, ramis pedunculatis, alternatim longe nodosis;* flores *sessiles, cum nodis articulati et plerumque tandem caduci, speciosi;* fructus *cylindrice oblongus, vix notus.*

1. CHYDENANTHUS EXCELSUS, nob.: *Barringtonia excelsa*, Blume (non Benth.), Bijdr. 1097; Miq. Fl. Ned. Ind. i. p. 491: *Stravadium excelsum*, Bl. in DC. Prodr. iii. 289; Bl. in Van Houtte, Fl. Serr. vii. p. 24: arbor alta, ramulis pallide brunneis, opacis: foliis oblongo- vel lanceolato-ellipticis, apice subito et acute attenuatis, imo obtusis vel acutioribus, marginibus cartilagineis subrevolutis vix repando-serratis, chartaceis, supra pallide viridibus, valde opacis, sub lente granulosis, nervis tenuissimis subadscendentibus arcuatim nexis, semiimmersis, costa tenui, subtus pallide fulvescentibus, opacis, minute granulosis, costa nervis stramineis venisque transversim reticulatis subprominentibus; petiolo semitereti, corrugulato, limbo 20plo breviore: racemis axillaribus et simplicibus, folio dimidio brevioribus, vel terminalibus, longioribus et ramoso-paniculatis, fulvide tomentellis, ramis remotis aut verticellatim congestis, imo (ut in axillaribus) nudis, supra medium spicati-floris, nodis crassis projectis, alternis, erecto-divaricatis, singulis 1-floris; floribus hinc sessilibus et articulatis, plerumque caducis; calycis limbo cupuliformi, margine membranaceo, undulato, obsolete 4-lobato, griseo, puberulo; petalis 4, obovatis, quorum 2 paullo majoribus, membranaceis, minute puberulis, unguibus tubo staminigero affixis; staminibus numerosissimis, petalis longioribus, imo in tubum brevem monadelphis, seriebus interioribus eximie brevioribus, tenuioribus, anantheris, ad basin fere liberis; disco annulari, extus tubum staminigerum fulciente, margine interno in tubulum crassum sulcatum stylum ambiente expanso; ovario infero, cylindrico, 8-sulcato, distincte 2-loculari, ovulo unico in quoque loculo e basi erecto: drupa elongato-ellipsoidea, utrinque obtusa, tetragona. Java, in maritimis: *v. s. in hb. Mus. Brit.* Prowats (*Horsfield*); in hort. Bogor cult. (*Anderson*); *in hb. Hook.* Java (*a cl. Miquel missa*): *fructus non vidi.*

Miquel's specimen certainly belongs here, and, though named by him *Barringtonia Vriesii*, does not correspond with the species published under that name by Teysmann and Bennenden. The details given by Blume are extremely short. He describes it as a tree 80 feet high; its leaves are 5–7¾ in. long, 2–2¾ in. broad, on petioles 3–4 lines long. This is one of the rare instances hitherto known in the family where a paniculated inflorescence occurs; this is accompanied by other characters, showing it to form a distinct genus: the rhachis is 4–10 inches long, with 4 alternate branches somewhat distant, 2–3 in. long in one specimen, while in another these branches are fasciculated or alternate upon a common peduncle 2 in. long; each branch has many projecting alternate thick nodules 1–2 lines long and 1–2 lines apart, each supporting a sessile flower articulated upon it: the ovary is like a pedicel, 1 line long, ½ line thick; the cupular calyx is 2 lines long, 3 lines broad; the petals are submembranaceous, horizontally extended, two of them 9 lines, the others 8 lines long, and 4½ lines broad; the outer stamens, 1 inch long, are united at their base into a tube 2½ lines long, the inner ones are almost free to the base, finely capillary, 3 lines long, and without anthers.

Blume makes this species a section (*Anisostemon*) of his *Stravadium*, distinguished by its peculiar inflorescence and its remarkably short interior stamens.

Blume, in his Bijdragen, p. 1087, says that this plant is the same as the *Barringtonia Vriesii* of Teysmann and Bennenden, which he suggests should be expunged. But Miquel does not accord in this view, and he quotes afresh the details given by the latter authors, that the inflorescence is an erect terminal raceme with dense flowers, seated upon separate pedicels bibracteolated at their base. He thinks it should be placed in a separate genus; but he confesses that he had not seen any specimen of it. I have referred it to the genus *Doxomma*.

A drawing of this species (with its floral analysis) is shown in Tab. XVII. figs. 15 to 20.

DESCRIPTION OF THE PLATES.

Plate X.

Fig. 1. A leaf of *Barringtonia speciosa*, from Forster's own specimen.

2. A flower of the same in bud, showing its entirely closed calyx.
3. The flower expanded, copied from Forster's drawing.
4. The stamens of the same, combined in a monadelphous tube, which is cut open, and to which one of the petals is affixed by its claw: *all nat. size*.
5. One of the anthers: *much magnified*.
6. The ovary, with the persistent calyx, the disk, with its inner nectarial expansion, and style: *nat. size*.
7. A longitudinal section of the same, showing two of its four cells, with its suspended ovules, the epigynous disk, which supports the staminal tube on its outer margin, is crenately lobed in the middle, and with its outer margin expanded into a long tube, dentated at its apex, and surrounding the lower part of style.
8. The fruit crowned by the persistent calyx.
9. The same, with half of the sarcocarp cut away transversely, to show the fibres surrounding the endocarp.
10. The endocarp, with its surrounding fibres.
11. A transverse section of the 4-celled endocarp, with one of the enclosed seeds shown.
12. The embryo of the seed: *all nat. size*.

Plate XI.

Fig. 1. The flower, in bud, of *Agasta splendida*, showing its entirely closed calyx.

2. The same, with the calyx splitting into 2 lobes by the expansion of the petals.
3. A flower expanded upon its pedicel, which has a foliaceous bract in its middle, copied from Parkinson's drawing.
4. A longitudinal section of the ovary, calyx, staminal tube, seated on the outer margin of the epigynous crenated disk, and style; two of its four cells are seen with the suspended ovules.
5. A transverse section of its 4-celled ovary.
6. A longitudinal section of the drupe, crowned by the persistent calyx and style, and its single large seed enclosed in its rather thick pericarp: *all nat. size*.

Plate XII.

Fig. 1. Flower in bud of *Agasta indica*.

2. Calyx, opened, and ovary, from which the petals and stamens have fallen away.
3. One of the petals.
4. The stamens united into a monadelphous tube, which is cut open to show its form, the petals having been detached.
5. A longitudinal section of the calyx and ovary, showing two of its four cells, and surmounted by the style and disk, from the outer margin of which the staminal tube has fallen.
6. A transverse section of the ovary, showing its 4 cells.
7. The fruit crowned by the persistent lobes of the calyx; a quarter of the pericarp is cut away, to show the single suspended seed, marked by a groove left by pressure of the chord formed by the 3 abortive cells.
8. The fruit seen from below, showing its acutely quadrate form.
9. A transverse section of the mesopodal embryo, showing the line of junction of the exorhiza and neorhiza: *all nat. size.*

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10. The flower in bud of *Agasta asiatica*, with the bract at the base of the pedicel.
11. One of the four petals.
12. The monadelphous stamens combined at the base into a tube, which has fallen away from its attachment upon the outer margin of the disk.
13. The ovary, surmounted by the persistent lobes of the calyx, disk, and style.
14. A longitudinal section of the same, showing two of its four cells, the style, the disk with its inner margin expanded upwards, and its outer margin, from which the staminiferous tube has fallen.
15. A transverse section of the ovary, showing its 4 cells.
16. A fruit acutely 4-angled, the angles cordate at base upon the pedicel, surmounted by the persistent lobes of the calyx and the style: *all nat. size.*

Plate XIII.

Fig. 1. A flower in bud of *Butonica alba*.

2. The same after expansion.
3. The same, seen from below, showing its 4-lobed calyx, its 4 petals with retroflected margins.
4. The staminal tube with the petals attached, falling away from fig. 5.
5. The pedicel, ovary, and persistent calyx of the same, the corolla and stamens having fallen off.
6. A longitudinal section of the ovary, with the persistent calycine lobes, disk, and style.
7. A transverse section of the same, showing its 4 cells.
8. A diagram showing the æstivation of the petals.
9. A drupe of the same, according to the dimensions given by Rumphius (it appears smaller in his diminished plate 115): a quarter of the pericarp is cut away longitudinally, to show the single suspended seed.
10. A transverse section of the embryo, showing the line of junction of the exorhiza and neorhiza: *all nat. size.*

---

11. A portion of the raceme of *Butonica racemosa*, with the flower expanded.
12. A flower in bud, of the same.
13. One of the four petals separated (which are attached by their claws to the staminiferous tube).
14. The stamens united at base into a monadelphous tube, which is cut open, and which has fallen off from the external margin of the disk.

15. The ovary surmounted by the calycine lobes and style, the staminiferous tube having fallen off.
16. A longitudinal section of the ovary, disk, and style, showing two of its four cells.
17. The drupe according to the shape and size given by Rheede, Roxburgh, and Hermann; a quarter of its pericarp is cut away, to show the single enclosed seed: *all nat size.*

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18. A portion of the raceme of *Butonica Rumphiana* with the flowers in bud.
19. A flower in bud on its pedicel.
20. The petals and stamens of the same, expanded, and agglutinated to the monadelphous tube, which has fallen from the external margin of the disk.
21. A longitudinal section of the ovary surmounted by the calycine lobes, disk, and style.
22. A transverse section of the 4-celled ovary.
23. The drupe, according to the dimensions given by Rumphius, surmounted by the persistent calycine lobes; a quarter of its pericarp is cut away, to show the single enclosed seed.
24. A longitudinal section of the embryo, showing the neorhiza enclosed within the exorhiza: *all nat. size.*

Plate XIV.

Fig. 1. A portion of the raceme of *Butonica rubra*, with flowers in bud, and another expanded.
2. A drupe of the same, according to the shape given in the diminished drawing of Rheede, but enlarged to its proper dimensions.
3. A transverse section of the same, showing within the pericarp the neorhiza of the embryo surrounded by its exorhiza: *all nat. size.*
4. A flower in bud of *Butonica terrestris*, with its calyx entirely closed.
5. The same fully expanded, as seen from below, showing the 3 ruptured lobes of the calyx, the 4 petals, and the stamens.
6. The stamens united into a monadelphous tube, which is cut open, showing two of the four petals agglutinated to it by their claws.
7. A longitudinal section of the 4-celled ovary, with two of the cells and their suspended ovules, two of the lobes of the calyx, the epigynous disk, from the outer margin of which the staminal tube has fallen off, the inner margin being raised, with the style seated in the hollow vertex.
8. A transverse section of the same.
9. A drupe of the same, according to the dimensions given by Rumphius (it appears smaller in the diminished drawing of his plate 115): *all nat. size.*

---

10. A young bud of *Butonica alata*, with the calyx quite entire.
11. The same somewhat grown, with the calyx beginning to split into 4 lobes.
12. A longitudinal section of the same, showing two of its four cells, the epigynous disk with its inner margin elevated.
13. A full-grown fruit, from a specimen in the Museum of the Linnean Society.
14. A longitudinal section of the same, showing the form of its 4-winged pericarp, its single seed enclosing the embryo.
15. The embryo extracted, with its exorhiza surrounding the neorhiza, and easily separable from it: *all nat. size.*
16. The ovary, disk, calycine lobes, and style of *Butonica rotata.*
17. A fruit of the same, shown in longitudinal section, according to the dimensions given by Sonnerat.
18. A transverse section of the same, including the seed: *all nat. size.*

---

19. The fruit of *Butonica inclyta,* according to the dimensions given by Griffith under the name of *Barringtonia racemosa* (but not of Blume) : this is is seen in his plate 636, § 2, with analytical details, figs. 1–6, and is here seen in longitudinal section : the embryo of the seed is shown with its neorhiza beginning to separate from the exorhiza, the latter splitting into 4 lobes at both extremities, as in *Doxomma cochinchinense.*

---

20. A flower-bud of *Butonica samoensis,* the entire globular limb of its calyx being quite closed.
21. The ovary, with the limb of the calyx split into 3 lobes.
22. The stamens combined into a monadelphous tube, to which one of the four petals is shown attached by its claw, all having fallen from the disk.
23. A longitudinal section of the ovary, with two of its three calycine lobes, the epigynous disk, on the outer margin of which the staminal tube was seated, its inner margin being considerably raised, forming the deep hollow in the vertex in which the style originates.
24. A transverse section of the ovary, showing its 4 cells.
25. The drupe, of the size and shape figured by Gaudichaud under *Barringtouia racemosa*: *all nat. size.*

Plate XV.

Fig. 1. A portion of the raceme of *Megadendron macrocarpum,* from Horsfield's specimens and the excellent description of Hasskahl, showing flowers in bud, and another fully expanded, seen from beneath, with its 4 sepals, 4 petals with reflected margins, and expanded stamens.
2. Half of the staminal tube, viewed from within, to show the inner rows of capillary sterile short filaments, the more exterior series being longer and fertile.
3. A longitudinal section of the ovary surmounted by the calycine lobes, disk, and style.
4. A transverse section of the 4-celled ovary.
5. A drupe, of the shape and size described by Hasskahl, a quarter of the pericarp cut away, to show its single suspended seed.
6. The embryo of the seed, with its exhorizal portion beginning to split into 4 sections, as occurs also in Loureiro's specimen of *Doxomma cochinchinense.*
7. A longitudinal section of the same, showing the inner neorhiza ready to germinate.
8. A transverse section of the same.

---

9. A leaf of *Doxommn pendulum.*
10. Portion of a raceme of the same, copied from a drawing of a living specimen, by Parish, with flowers in bud, and another fully expanded, seen from beneath, to show its 4 petals with reflected margins.
11. A fruit of the same, from drawings of Parish and Griffith in his plate 634 A, under *Careya pendula* : seen in longitudinal section, with its single suspended seed.
12. The seed detached.
13. The embryo of the same, the testa being removed.
14. The embryo beginning to germinate.
15. The same germinating, seen in longitudinal section, showing the inner germinating portion (neorhiza) surrounded by the splitting exorhiza, according to the analysis of Griffith: *all nat. size.*

Plate XVI.

Fig. 1. A leaf of *Doxomma cochinchinense* (*Barringtonia acutangula,* Lour.), from Loureiro's original specimen in the British Museum.
2. A fruit of the same, from Loureiro's specimen, with four undulated angles.

3. A transverse section of the same, showing the embryo within the pericarp.
4. The embryo extracted, with the exhorizal portion splitting into 4 sections.
5. The same, seen in transverse section: *all nat. size.*

---

6. A leaf of *Careya orbiculata* from Griffith's specimen.
7. A flower, in bud, of the same.
8. The ovary of the same, from which the petals and stamens have fallen.

---

9. The ovary of *Careya sphærica,* crowned by its 4 sepals and style.
10. The monadalphous stamens, with the tube cut open, to show that the more external and more internal series of filaments are capillary and without anthers, the intermediate series alone being fertile: one of the four petals remains attached by its claw to the tube.
11. A longitudinal section of the ovary, showing two of its four cells, two of the sepals, the epigynous disk, on the outer margin of which the staminal tube was seated, the inner margin being raised, leaving a hollow in the vertex round the base of the style.
12. A transverse section of the same.
13. A drupe, crowned by the persistent sepals and style, a quarter of its pericarp being cut away to show the seeds imbedded in pulp, the latter having been removed.
14. One of the seeds.
15. The same, after germination, copied from Dr. Thomson's drawing: the neorhiza has sprouted into a rootlet at one extremity, while at the other it has thrown out a long naked stemlet, crowned at its apex by 4 young decussating leaves: *all nat. size.*

Plate XVII.

Stravadium acutangulum, DC.

Figs. 1 & 2. Drawing taken from the typical specimens of a Ceylon plant in the herbarium of Hermann, upon which Linnæus established his *Eugenia acutangula* and Gaertner his *Barringtonia acutangula,* with which numerous other species have been confounded.

3. A flower of the same, in bud.
4. The same, full-grown and expanded.
5. The ovary crowned by the calyx: *all nat. size.*
6. The same: *magnified.*
7. A longitudinal section of the same.
8. The staminal tube cut open, showing the stamens and two of its four petals agglutinated to it by their claws, all having fallen off from their attachment to the disk.
9. A transverse section of the ovary, showing it to be only 2-celled: *all equally magnified.*
10. The fruit, from Gaertner's drawing.
11. The same, with half of the pericarp removed, to show the enclosed seed.
12. The embryo of the seed.
13. A longitudinal section of the same, showing the neorhiza enclosed in the exorhiza.
14. A transverse section of the same, showing the exhorhizal portion splitting into 4 sections: *all nat. size.*

---

15. A portion of the plant of *Chydenanthus excelsus,* with its branching panicle, upon which an expanded flower is seen.
16. A flower in bud.

17. The cup-shaped calyx, with a truncated margin : *all nat. size.*
18. The monadelphous tube of the stamens, cut open, to show the inner row of short sterile filaments, the whole having fallen from the inner margin of the disk.
19. A longitudinal section of the ovary, crowned by the calyx, disk, and style.
20. A transverse section of the same, showing it to have only 2 cells : *the last three figures are somewhat magnified.*

Plate XVIII.

Fig. 1. A portion of the flowering specimen of *Planchonia crenata,* from Mr. Robert Brown's typical specimen in the British Museum; the branching panicle shows a flower in bud and another fully expanded.

2. The stamens united into a monadelphous tube, upon which one of the four petals remains, to show how they are agglutinated to it by their claws, the tube having fallen from its attachment to the outer margin of the disk.
3. The ovary, surmounted by the sepals and style.
4. A longitudinal section of the same, showing two of its four cells, and surmounted by the sepals, disk, and style.
5. A transverse section of the same, showing its 4 cells.
6. The drupe, drawn from Mr. Brown's specimen.
7. A longitudinal section of the same, crowned by the persistent sepals, disk, and style, and showing two of the four cells, with the seeds as they exist *in situ,* the pulp being removed.
8. A longitudinal section of another fruit, collected by Schomburgk ; this is gibbous, owing to the abortion of three of its cells, and it contains 4 seeds, horizontally attached to the axis, and apparently once imbedded in pulp, as in the preceding specimen.
9. One of the seeds, on its short thick funicle.
10. The same, deprived of its membranaceous integument and funicle, showing a depressed hollow on one side below the apex : seen on its face.
11. The same, viewed on its edge.
12. A longitudinal section of the same, seen from the interior of one of the faces, from which the loose embryo has been removed : it is an envelope of thick firm texture, opaquely white, seeming like an albumen.
13. The embryo extracted : *all nat. size.*
14. The same, *magnified,* showing the thick subtruncated terete radicle, upturned suddenly near the base, and supporting the two roundish fleshy subplicated cotyledons.
15. An edge view of the same : *equally magnified.*

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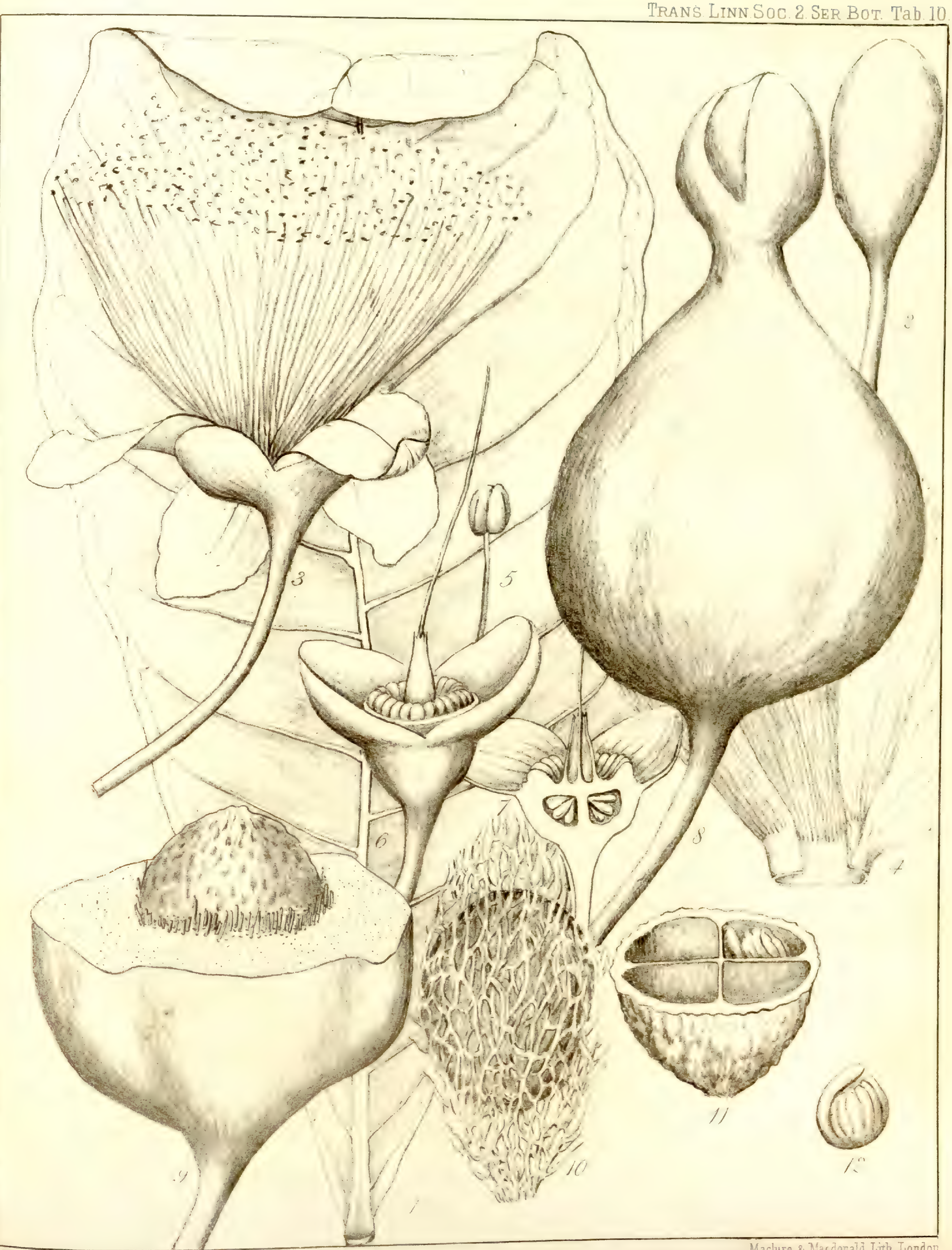
16. A portion of a plant of *Petersia africana,* from a specimen given to me by Dr. Welwitsch.
17. A flower on its pedicel.
18. The ovary and calyx, the petals and stamens having been removed : *all nat. size.*

19 is an enlarged view of fig. 17, showing its 4-winged inferior ovary, crowned by the 4 sepals alternate with the wings and the 4 petals.

20. A longitudinal section of the ovary, disk, and style.
21. A transverse section of fig. 20.
22. The monadelphous stamens detached from the outer margin of the disk : *all magnified.*
23. An anther, seen before and behind : *more magnified.*
24. A fruit, with its 4 large membranaceous wings.
25. The pericarp of the same, deprived of its wings.
26. A longitudinal section of the same : *all nat. size.*



J. Miers, del.

BARRINGTONIA SPECIOSA.

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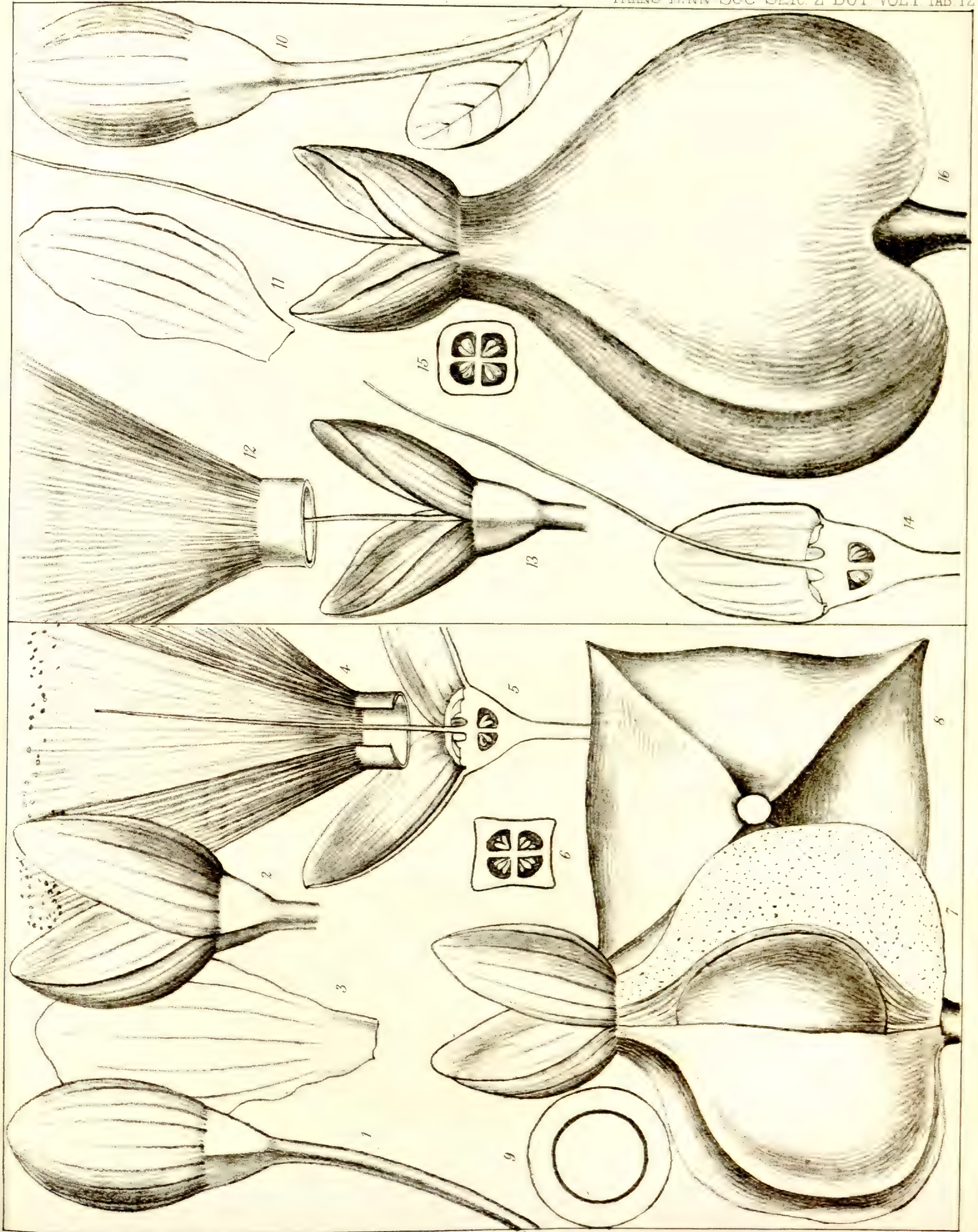
AGASTA SPLENDIDA.



AGASTA ASIATICA.

AGASTA INDICA.

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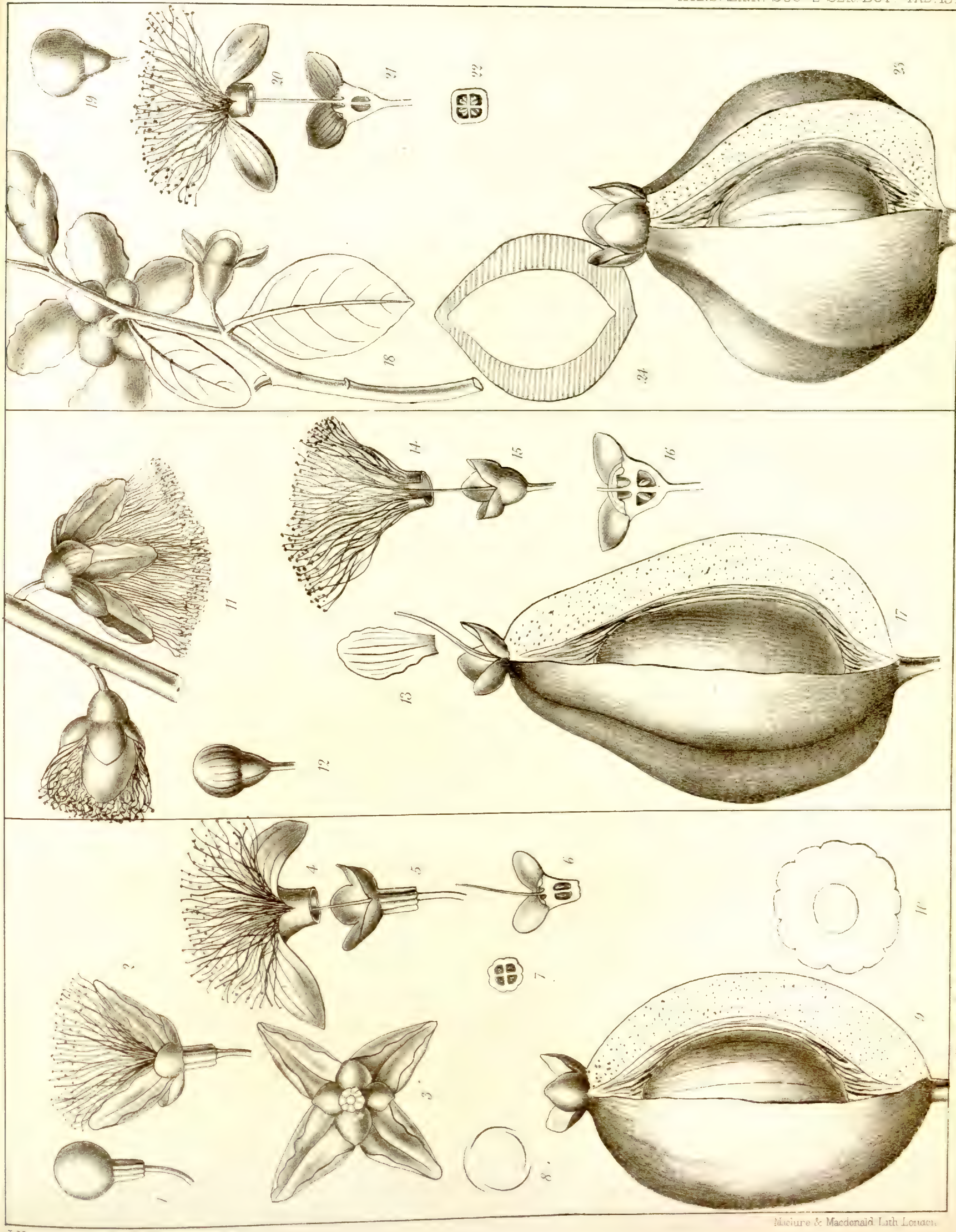

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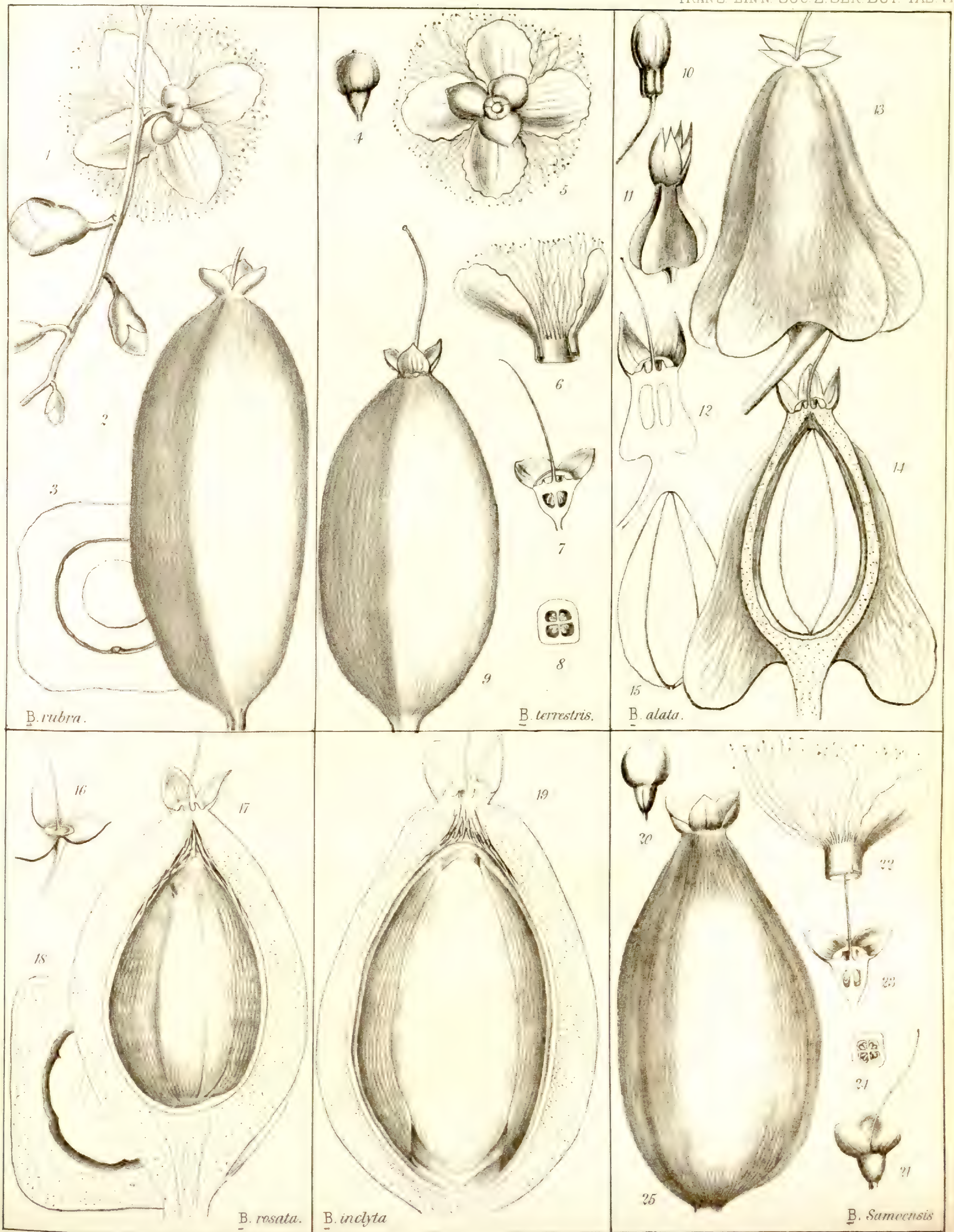

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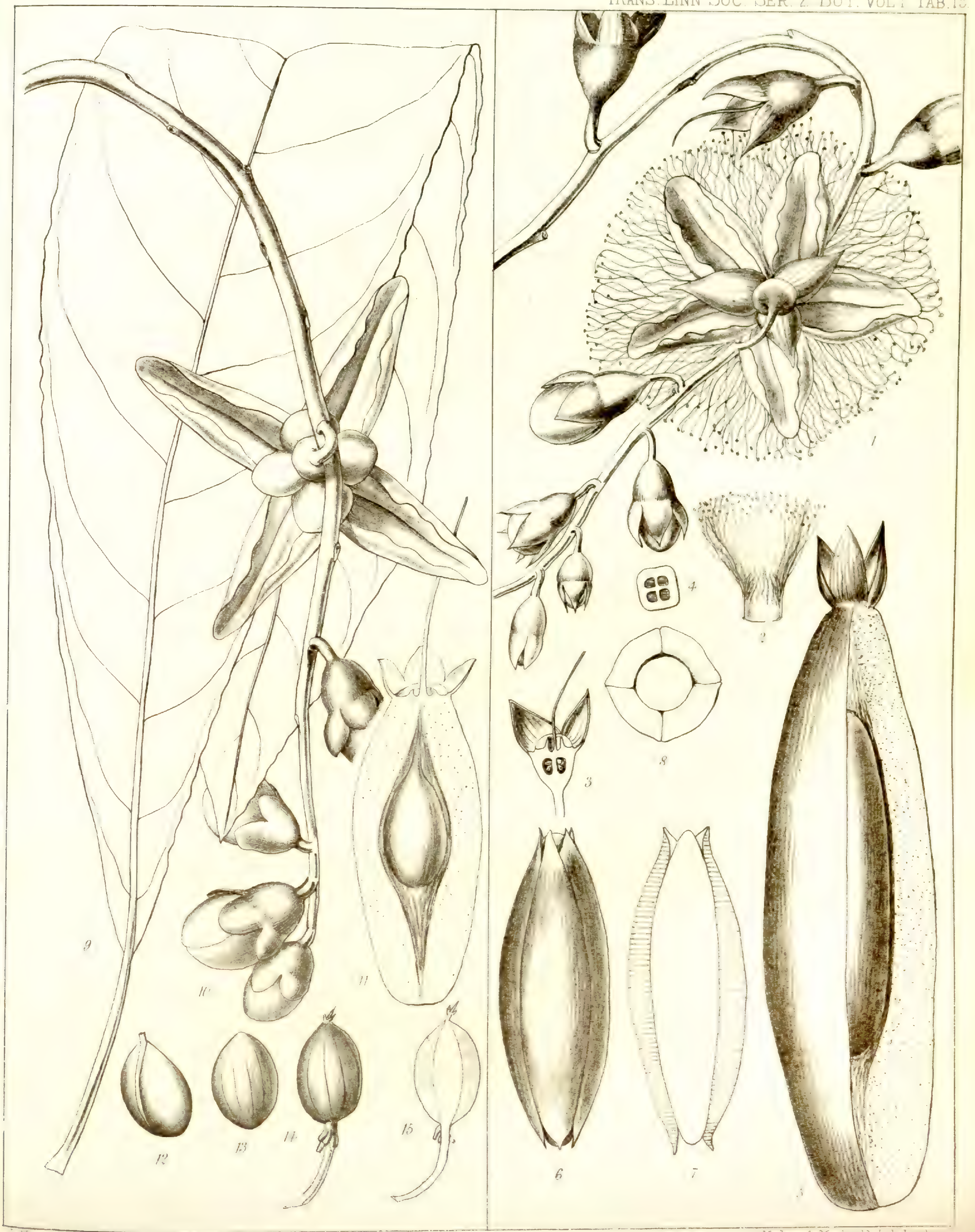

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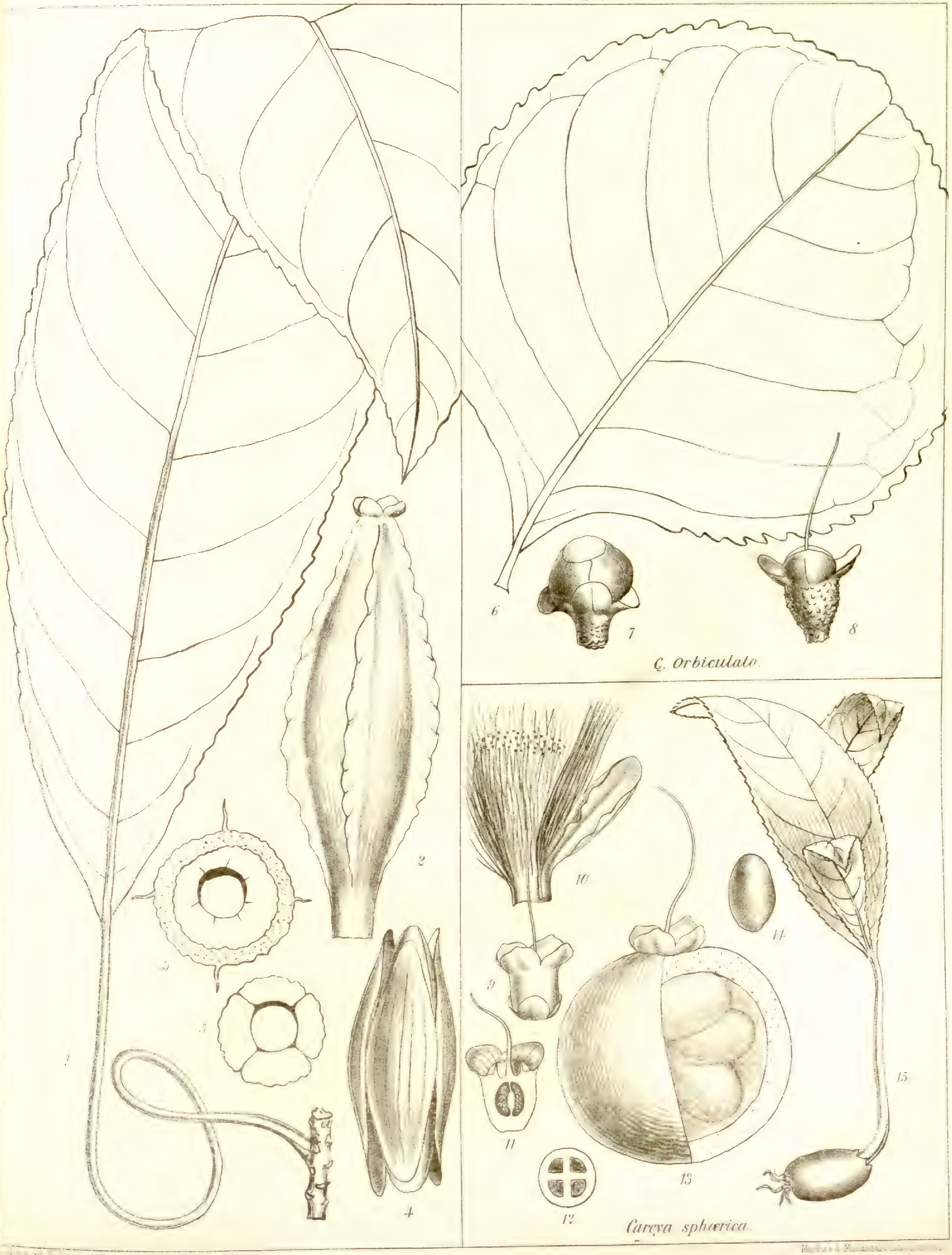

CAREYA.

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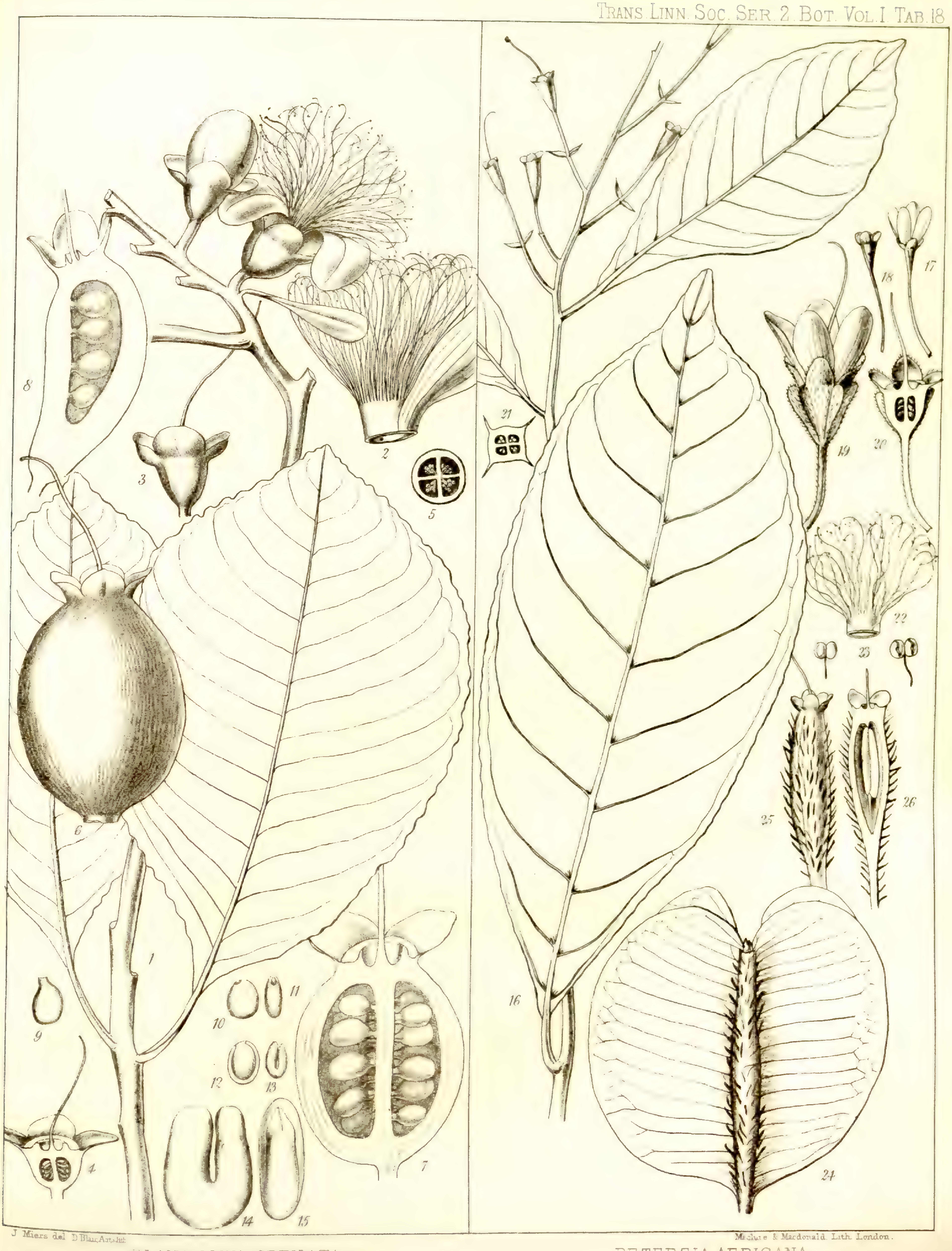
STRAVADIUM ACUTANGULUM

CHYDENANTHUS EXCELSUS



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PLANCHONIA CRENATA.

PETERSIA AFRICANA.

THE TRANSACTIONS OF THE LINNEAN SOCIETY OF LONDON.

SECOND SERIES.—BOTANY.

VOLUME I.

PART THE THIRD.

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M.DCCC.LXXVI.

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(Plates 19–21.)

Read June 4th, 1874.

THE fungi to which this paper relates were collected mostly in Pegu by Mr. Sulpiz Kurz, Curator of the Botanic Garden at Calcutta. I am not aware that any collections of fungi have heretofore been made in Pegu, and an interest therefore attaches to the present one as being so far the first of its kind. As might be expected, many well-known tropical forms occur. There are several species, especially amongst the *Polyporei*, which, although previously described, are by no means well known; and it will be seen that there are some new forms of considerable interest. In the examination of the plants I have had the advantage of access to Mr. Berkeley's valuable herbarium, for which, and for his kind assistance in the determination of some of the species, I am desirous of expressing my acknowledgments.

AGARICINI.

Several species of *Agaricus* accompanied the other fungi; but it is hopeless to attempt to name specimens of this genus unless they are accompanied by coloured drawings of the fresh plant, careful sectional figures, and notes of the colour and shape of the spores. Micrometric measurements of the spores should be added in all cases where practicable. Amongst the specimens were some which appeared to belong to *Ag. silvaticus*, Fr., and *Ag. fimicola*, Bolt., and others which were identical with or allied to *Ag. spadiceus*, Fr., and *Ag. picreus*, Fr. Others, belonging to the subgenera *Lepiota*, *Tricholoma*, *Volvaria*, *Psathyra*, and *Psathyrella*, were not further determinable. One small Agaric is noted as being used for food. It resembles *Ag. semiorbicularis*, Bull.; but that plant is not edible. Two species of *Marasmius* occur, one of which has not dried well: the other (No. 3472), in the dried state, is just like *M. ramealis*, Fr.; but Mr. Kurz describes it as *white* when fresh, so that it can hardly be that species.

Lentinus capronatus, Fr. Epicrisis, p. 390; Persoon in Freycinet's Voyage, t. 2. f. 3.—Myodwine, Evergreen Forests, Pegu. No. 2604.

This is an interesting series of specimens, varying in the size of the pileus from $\frac{3}{4}$ inch to $1\frac{1}{2}$ inch. In three of the plants the pileus is distinctly zoned. The gills cannot be called denticulate, although some are very slightly uneven at the edge. The figure in 'Freycinet's Voyage' is very good, but the specimens there represented are small.

L. descendens, Fr. Epicr. p. 390.—Tonkyeghat, Pegu, Evergreen Forests. No. 2629.

This species was found by Afzelius in Guinea, in gravelly soil. It is figured by him in

the 'Fungi Guineenses,' t. x. fig. 22. The specimen is in bad condition, and I have some doubts about the species.

Lentinus furfurosus, Fr. Epicr. p. 391.—Yomah, Pegu. No. 3474 *.

L. velutinus, Fr. Epicr. p. 392.—Yomah, Pegu. No. 3498.

L. glabratus, Mont. Cuba, p. 424. No. 1779.—North Rajmehal hills, N. Bengal.

There are but two specimens of this species, and they have not been very successfully dried. The margin of the pileus can hardly be called hairy; but in all other respects the plant agrees with *L. glabratus.*

L. Sajor Caju, Fr. Epicr. p. 393. Rumph. Amb. t. 56. f. 1.—South Andaman. Nos. 2560, 2561.

"Sajor Caju" is the Malay name of the plant.

L. exilis, Fr. Epicr. p. 393.—Tonkyeghat, Nakawa, Evergreen Forests, Pegu. No. 2592. Sittang valley, Pegu. Nos. 3487 & 3488.

L. inquinans, Berk., Hooker's Journal of Botany, 3rd series, vol. iv. p. 130, t. vii. f. 1.—Kemendine, Jack Tree Gardens, near Rangoon, Pegu. No. 2600.

I think there is no doubt about the species, although the single specimen gathered by Mr. Kurz varies from the type in some particulars. The gills are somewhat narrower, and the warts and the brown pubescence of the pileus have rubbed off in drying; but there are dark spots all over the pileus, showing the places where the warts were attached. The bristles have disappeared, except here and there at a short distance from the margin, where they are still plainly visible under a lens, and the transverse scales on the stem are not now to be seen. The latter, however, like the warts, may have been rubbed off in drying. Mr. Berkeley has noticed that in some dried specimens a pellicle separates from the umbilicus, carrying the warts with it and leaving the pileus smooth.

L. Kurzianus, n. sp. *Pileo* lento, infundibuliformi, furfuraceo-squamuloso, fusco; *stipite* brevi, fusco-ferrugineo, ad basin nigricante; *lamellis* profunde decurrentibus, læte rubiginosis.—Yomah range, Pegu. No. 3497.

This is a beautiful species, in many points resembling *L. furfurosus*, Fr., from which it differs in the deeply funnel-shaped pileus and in the colour of its gills. In *L. furfurosus* the mycelium (held together by the sand in which it grows) forms an indurated tuberiform root. In the specimens of the present species the stipes has the appearance of having been broken off in gathering; so that it is not improbable that a tuberoid radix may be present in the perfect state, which would bring the plant still nearer to *L. furfurosus*, Fr. The colour of the gills varies from a bright rust-colour to a greyish brown, according to the incidence of the light under which they are examined.

Plate 20. fig. 11. Plant, natural size.

L. cæspitosus, n. sp. Dense cæspitosus. *Pileo* infundibuliformi, squamis subconcentricis ornato; *stipite* versus basin attenuato; *lamellis* substipatis, decurrentibus, (siccis) brunneis.—Pegu. No. 2624. No special locality is given.

* In the specimens of this species the stems have been broken off short in gathering, so that there is no tuberiform radix, and the gills are too dark-coloured to be described as "*flavidis*;" but the plant comes so near in other respects to *L. furfurosus*, Fr., that I do not venture to propose it as a new species.

I find no species described which agrees with this. The plant is stated to be white when fresh. In the dried state it is of a brownish fawn-colour, the gills being somewhat darker than the pileus.

Plate 19. figs. 4 and 5. Fig. 4, a group of plants, natural size; fig. 5, a single plant.

LENTINUS IRREGULARIS, n. sp. *Pileo* (sicco) nigricante, fragili, infundibuliformi; *lamellis* cinnamomeis, irregularibus, hic per totum stipitem decurrentibus, illic annulatim abruptis.—Karen country. Pine-forests from Theemeechu to Borkee. No. 2534.

There are four specimens of this species, in two of which the gills run down the whole length of the stem, whilst in the other two they terminate abruptly, and break off in a way very similar to what is seen in the British species *L. fimbriatus*, Curr. If the two latter specimens only had been examined, I should probably have referred them to *L. fimbriatus*.

Plate 19. figs. 14 and 15. Plants, natural size.

SCHIZOPHYLLUM COMMUNE, Fr. Several specimens of this species occur in Mr. Kurz's collection.—The localities are:—Botanic Garden, Calcutta, Nos. 1781 and 2649; Ross Island, South Andaman, No. 2562; Sikkim Himalaya, Nos. 2572 and 2575; Tonkyeghat, Pegu, No. 2598.

LENZITES ALBIDA, Fr. Epicr. p. 405.—Tonkyeghat, Pegu. No. 2601.

I have seen no specimens of *L. albida*, Fr. No. 2601 agrees with the description in the 'Epicrisis,' except in being stipitate and in the gills having a cinnamon-colour. Nothing is said by Fries as to the size of *L. albida*. The pileus in the present plant measures $\frac{7}{8}$ of an inch by $\frac{5}{8}$ of an inch, and at first sight much resembles *Panus stypticus*, Fr.; but the anastomosing gills show that it cannot be that species.

L. PALISOTI, Fr. Epicr. p. 404.—Seven Pagodas, Evergreen Forests, Tonkyeghat, Pegu. No. 2590.

There is another specimen in the collection (No. 2604), which seems to be the same species, from the Botanic Garden, Calcutta.

POLYPOREI, Fr.

POLYPORUS (MESOPUS) PERENNIS, Fr. Epicr. 434; ib. Hym. Eur. 531.

Sent by Dr. Stoliczka from Penang. No. 2041.

P. (MESOPUS) XANTHOPUS, Fr. Epicr. 437.—Pegu, Nakawa, Evergreen Forests, Tonkyeghat, No. 2533; Sittang valley, Pegu, No. 3489; Yomah range, Pegu, No. 2627.

There is also a specimen from South Andaman, No. 2563.

P. (MESOPUS) FLORIDEUS, Berk., Hooker's Journal of Botany, 3rd series, vol. vi. p. 137.—Pegu, Karen country, Bookee ridges, 5000–6000 feet, Pine-forests, No. 2595.

This species was found by Dr. Hooker at Darjeeling, at a height of 7500 feet.

P. (MESOPUS) HYPOPLASTUS, Berk., Hooker's Journal of Botany, vol. viii. p. 174.—Howrah district. On bamboo. No. 2652.

This species was first found by Mr. Spruce at Panuré. Mr. Berkeley has noticed that the pileus is sometimes lateral; and this is the case with three out of the four specimens sent by Mr. Kurz. Judging from Mr. Kurz's specimens alone I should have placed the plant in the division *Pleuropus*.

POLYPORUS (MESOPUS) CRASSIPES, n. sp. *Pileo* lignoso, infundibuliformi, fusco-purpureo, margine umbrino et zonato; *stipite* durissimo, badio, ad basin incrassato; *poris* minutissimis, stipite pallidioribus.—Yomah river, Pegu. There is no number to the specimen.

This plant resembles in some points *P. parvulus* and *P. carbonarius*, Fr., but differs widely in other respects. I do not know any species to which it can be referred.

Plate 19. fig. 13. Plants of the natural size.

P. (PLEUROPUS) SANGUINEUS, Fr.

This common tropical species occurs in Mr. Kurz's collection from Mutlah, in Lower Bengal, No. 2031; from the Botanic Garden, Calcutta, No. 2682; and from Tongloo, Sikkim Himalaya, 5000–6000 feet, No. 2584.

P. (PLEUROPUS) MODESTUS, Kunz, Fr. Linn. v. p. 519; Fr. Epicr. p. 444.—Yomah range, Northern Pegu, No. 2610.

This is the same species as *P cervino-nitens*, Schweinitz.

P. (PLEUROPUS) FLABELLIFORMIS, Kl., Fries, Epicr. p. 444.—Yomah range, Pegu, No. 3491.

P. (PLEUROPUS) AFFINIS, Fr. Epicr. p. 445.—Yomah range, Pegu, Nos. 2628 & 3490. Evergreen Forests, Bookee ridges, Karen country, 5000–6000 feet, No. 2617.

No. 2617 has a very short stem and an irregular margin, but I cannot make it out to be any other species.

P. (PLEUROPUS) PICIPES, Fr. Epicr. p. 440.—Botanic Garden, Calcutta, No. 2655.

There is also a specimen from Sikkim without a number.

P. (PLEUROPUS) LUCIDUS, Fr. Epicr. p. 442.—Botanic Garden, Calcutta, No. 2684. The yellow form of the species.

P. (PLEUROPUS) AMBOINENSIS, Fr. Epicr. p. 442.—Karen country, Pegu, 4000 feet. No. 2636.

This is a very variable species, probably not distinct from *P. lucidus*, Fr.

P. (PLEUROPUS) SPLITBERGERI, Mont. Cent. ii. no. 83; Sylloge, p. 164. no. 522.—Nattoung Hills, Pegu, 6000–7000 feet. No. 2638.

Plate 19. figs. 2 and 3. Fig. 2, the under side of the plant; fig. 3, the upper side: natural size.

This *Polyporus* agrees almost to the letter with the description of *P. Splitbergeri* in the 'Sylloge,' although the character "contextu aureo-nitido" is hardly applicable to the present plant. In the figure the pileus appears zonate, but the apparent zones are rather imbrications produced by the successive growths of the pileus. In *Polyporus Nilgheriensis*, Mont. (Sylloge, p. 164. no. 523), a closely allied species, the pileus is described as "antice prole nova subimbricata," and this description is exactly applicable to the present specimen of *P. Splitbergeri*. This plant being stemless, it might be thought that it ought to be placed in the division *Apus*; but it clearly belongs to the "prolificans" division of Fries, as described in his 'Novæ Symbolæ Mycologicæ,' p. 161, in which division the stem is sometimes wanting.

P. (PLEUROPUS) BRUNNEO-PICTUS, Berk., var.—Arracan, Kolodyne valley, on old wood. No. 2045.

Plate 19. figs. 11 and 12. Fig. 11, the under side; fig. 12, the upper side: natural size.

This plant comes so near to *P. brunneo-pictus*, Bk., that I do not venture to propose it as a new species. It differs in its obsolete stem and in the nature of its pores. In *P. brunneo-pictus* the apices of the pores are papular, with a central aperture; and slight traces of this structure may be seen at the extreme margin in Mr. Kurz's plant, in which, however, the pores are not generally porotheloid, although the dissepiments are unusually thick. *P. brunneo-pictus* is described in Hooker's Journal of Botany, 3rd series, vol. viii. p. 176.

POLYPORUS (APUS, ANODERMEI) FUNALIS, Fr. Epicr. 459.—Lower Bengal, Mutlah tidal jungles. No. 2029.

This species is admirably figured in Afzelius's 'Fungi Guineenses,' t. i. f. 3.

P. (APUS, ANODERMEI) RUBIDUS, Berk. London Journ. Bot. vol. vi. p. 500.—Pegu. Nos. 2621, 2622.

Plate 20. figs. 5 and 6. Fig. 5, the upper side; fig. 6, the under side of a plant: natural size.

The hymenium differs little in colour from the upper side of the pileus. The pores are very small, just visible to the naked eye. The plant varies in the brightness of its tint, although always exhibiting a tinge of flesh-colour. In one of Mr. Kurz's specimens the pilei are imbricated, and one has a distinct lateral stipes, showing a variability of habit. The species was first found by Gardner at Point de Galle, Ceylon, on fallen trees.

P. (ANODERMEI) INCERTUS, n. sp. *Pileo* in centro tenuissimo, marginem versus incrassato et reflexo, leviter zonato, dilute cervino; *poris* amplis, profundis, irregularibus, cervinis.

Pileus very thin, almost obsolete, except at the margin, where it is thicker, reflexed, slightly zoned, and fawn-coloured. Pores large, deep, irregular, somewhat darker than the pileus.

Plate 19. figs. 6 and 7. Fig. 6, a portion (rather more than half) of a plant, natural size; fig. 7, a section.

This is a difficult plant to describe technically on account of its great irregularity of growth. It has the appearance of having grown in an almost resupinate position, but with the margin to a certain extent free all round. The figure will give a better idea of it than any amount of description. Its systematic position is doubtful. It is certainly not one of the veritable "Resupinati;" but whether it belongs to the "Anodermei" or the "Inodermei" is very difficult to decide in the dry state. It has no appearance of having ever been "succose;" but, on the other hand, I see no trace of a cuticle.

P. (PLACODERMEI) APPLANATUS, Fr.—Pegu, Tonkyeghat, Evergreen Forests, Tonnghoo. No. 2686.

P. (PLACODERMEI) MARGINATUS, Fr.—Bookee, Pine-forests, 4000–6000 feet, Karen country, Pegu. No. 2586.

P. (PLACODERMEI) PERSOONII, Fr.—Pegu, Nakawa, Evergreen Forests, Tonkyeghat. No. 2593.

P. (PLACODERMEI) HOLOSCLERUS, Berk. Lond. Journ. Bot. vol. vi. p. 479.—Pegu, Yomah, Myodwine, Evergreen Forests. No. 2614.

POLYPORUS (APUS, PLACODERMEI) CINEREO-FUSCUS, n. sp. *Pileo* dimidiato, lignoso, durissimo, margine tenui, basin versus incrassato, fusco-cinereo, rugoso-tuberculoso; *poris* minimis, cinereo-fuscis.

Pileus $1\frac{1}{2}$–2 inches wide, of a dull brown colour, with blotches of black, thin at the margin but thickening rapidly towards the base, longitudinally rugose with tubercles; pores very minute, blackish brown, sometimes almost quite black.—Pegu, Nakawa, Evergreen Forests, Tonkyeghat. No. 2606.

Mr. Berkeley was inclined to refer this plant to his *Polyporus ferreus* (London Journ. Bot. vol. vi. p. 502. no. 175); but it differs from that species in its dark pores and in some other characters. It is allied to *P. fasciatus* and *P. supinus* of Swartz.

Plate 19. fig. 1. Plant, natural size.

P. (INODERMEI) CINNABARINUS, Fr. Epicr. p. 473.—On old logs, Botanic Garden, Calcutta. No. 2681.

P. (INODERMEI) SCRUPOSUS, Fr. Epicr. p. 473.—Martaban Hills, Shan toung gyre toung, 3800 feet. No. 3492.

P. (INODERMEI) FEEI, Fr. Epicr. p. 476.—Pegu, Yomah. No. 3493.

P. (INODERMEI) VERSICOLOR, Fr. Epicr. p. 478.—Sikkim Himalaya, 7000 feet, on dead wood. No. 2567.

P. (INODERMEI) PINSITUS, Fr. Epicr. p. 479.—Nattoung ridges, Karen country, 6000 feet. No. 2608.

A. (INODERMEI) CINERASCENS, Fr. Epicr. p. 481.—Yomah, Northern Pegu. No. 2609.

Fries describes the pileus in his *P. cinerascens* as fuscous, and the pores as cinereous. In Mr. Kurz's plant the pileus is rather ochraceous than fuscous, and the pores are reddish brown. These differences in colour are hardly sufficient to separate it as a species.

P. (INODERMEI) ANEBUS, Berk. Lond. Journ. Bot. vol. vi. p. 504.—Tonkyeghat, Pellowa, Evergreen Forests, Pegu. No. 2599.

This is a small thin form of Mr. Berkeley's species. From Mr. Berkeley's remarks (*loc. cit.*) it seems to be a variable plant.

P. (INODERMEI) XEROPHYLLACEUS, Berk., Hook. Journ. Bot. 3rd series, vol. viii. p. 200. No. 2658.—Botanic Garden, Calcutta, on old logs in the rainy season.

Mr. Kurz's specimens agree very well with Mr. Berkeley's description. In some the pilei are confluent laterally, in others imbricated. I should rather have placed the plant in the "Anodermei," but have retained Mr. Berkeley's division.

Plate 20. figs. 1 and 2. Plants, natural size.

TRAMETES LOBATUS, Berk., Hook. Journ. Bot. 3rd series, vol. iii. p. 84.—N. Bengal, Sikkim Terai, on old logs. No. 2569.

T. UMBRINUS, n. sp. *Pileo* resupinato, effuso-reflexo, lobato, subtomentoso, leviter zonato; *poris* amplis, dentato-laceris. No. 2611.—Pegu, Nakawa, Evergreen Forests, Tonkyeghat.

Plate 21. fig. 4. Plants, natural size.

It is difficult to say whether the larger specimen is a single plant or a mass of

confluent pilei. The pores underneath the slightly reflexed marginal lobes are at right angles with the pileus. In the centre the pores become elongated and decurrent, overlapping one another in an imbricated manner.

TRAMETES OCCIDENTALIS, Fr. Epicr.—Botanic Garden, Calcutta. On old logs in the rainy season. No. 2656.

I have had a little doubt about this species, as the pileus is not "effuso-reflexed," which is one of the characters of *T. occidentalis.* In Mr. Kurz's specimens the pilei are dimidiate. Substituting "dimidiato-" for "effuso-reflexo" in Fries's description, the latter applies exactly to Mr. Kurz's plant.

T. CINGULATUS, Berk., Hook. Journ. Bot. 3rd series, vol. vi. p. 164.—Pegu, Yomah. No. 3475.

Other specimens in Mr. Kurz's collection from the Botanic Garden, Calcutta (Nos. 2679 & 2685), show that this species varies a good deal in the thickness and in the pubescence of the pileus, the latter being sometimes silky, sometimes woolly in its appearance. The pubescence, of whichever kind, is always slight, a lens being almost necessary to see it distinctly.

DÆDALEA.

DÆDALEA TENUIS, Berk.—Pegu, Yomah. No. 2603.

Another specimen of this species from South Andaman Island occurs in Mr. Kurz's collection.

D. DISCOLOR, Fries, Epicr. p. 494.—Pegu, Yomah. No. 3503.

D. ZONATA, Fr. Epicr. p. 494.—Pellowa, Evergreen Forests, Tonkyeghat, Pegu. No. 2589.

I have not seen specimens of Fries's *D. zonata.* The present plant only differs from Fries's description in the pileus being wrinkled and very slightly pubescent, characters which hardly justify its being made a new species. I should place it under *D. zonata* as var. *rugoso-pubescens.*

HEXAGONIA, Fr.

HEXAGONIA POLYGRAMMA, Mont. Fr. Epicr. p. 497; Mont. Sylloge, p. 169; Cuba Crypt. (Ramon de la Sagra), p. 379, t. 14. f. 3.—Pellowa, Evergreen Forests, Tonkyeghat, Pegu. No. 2597.

H. TENUIS, Fr. Epicr. p. 498.—Pegu, Elephant Point. On old trees along the shore. No. 3484.

This is exactly the plant of Fries, agreeing in every particular. There are two other forms (both from Yomah) in the collection (Nos. 3494 & 3505), which I cannot satisfactorily separate from *H. tenuis.* No. 3494 differs in having a darker-coloured pileus and smaller pores, the latter being brown, without the grey tinge of the pores of *H. tenuis.* In No. 3505 the pileus and pores are precisely similar in colour to those of No. 3494, but are a good deal larger.

HEXAGONIA KURZI, n. sp. *Pileo* coriaceo, glabro, orbiculato aut reniformi aut dimidiato, corrugato, zonato, rubro-fusco; *alveolis* amplis, intus canescenti-fuscis, acie cinnamomea.—Mutlah. No. 2028.

Plate 20. figs. 3, 4, and 7. Figs. 3 and 7, the upper side; fig. 4, the under side of different plants: natural size.

This species comes very near to *H. nitida*, D.R. et M. It differs in having the pileus sometimes quite circular, and in the colour of the pores, which are of a pale bright grey in the inside, with the edge of a distinctly cinnamon-colour.

HYDNEI.

HYDNUM UDUM, Fr. Epicr. p. 517—Mutlah, Calcutta. No. 2030.

TREMELLODON GELATINOSUM, Fr. Hymenomycetes Europæi, p. 618.—Sikkim, 7000–8000 feet. No. 2573.

Tremellodon is a genus formed by Fries to include *Hydnum gelatinosum*, Scop., and *H. auriculatum*, Fr. These plants have the aculeate hymenium of *Hydnum*, but the fructification of *Tremella*. See Linn. Journ. vol. v. p. 181.

IRPEX FLAVUS, Kl.; Fries, Epicr. p. 522.—Arracan, Baronga Islands, on old wood, 1000 feet. No. 2047.

I. PALLESCENS, Fr. Epicr. p. 522.—Yomah, Pegu. No. 3495.

There is one other *Irpex* in the collection (No. 3486) from the Sittang valley, Pegu. It has been partially destroyed by insects, and is not certainly determinable; but it must, I think, be either *I. flavus*, or *I. sinuosus*, Fr.

GRANDINIA GRANULOSA, Fr. Epicr. p. 527.—Pellowa, Evergreen Forests, Tonkyeghat, Pegu. No. 2594.

AURICULARINI.

THELEPHORA PUSILLA, n. sp. Pusilla, fuscescens, simplex vel ramosa, sursum cristato-divisa.—Sikkim Himalaya, 2000–2500 feet. No. 2570.

This species is evidently allied to *T. cristatella*, B. & Br. (a Ceylon plant), but it differs in the colour, which varies from light to dark brown, and in the divisions, which are rather clavate than acute.

Plate 21. fig. 9. Plants, natural size.

T. PALMATA, Fr. Epicr. p. 537.—Botanic Garden, Calcutta. On bamboo-trunks. No. 2661.

STEREUM ELEGANS, Fr. Epicr. p. 543.—In bamboo-jungles, but the locality is not given. No. 1792. Lower Pegu, junction of Pegu river and Khayasoo Choung. No. 2631.

The specimens under the latter number are very small, but there is no doubt about the species.

S. OSTREA, Fr. Epicr. 547.—Sikkim Himalaya, 4000–6000 feet. No. 2579.

S. LOBATUM, Fr. Epicr. p. 547.—Pegu, Tonkyeghat, the seven Pagodas. No. 2596.

In Mr. Kurz's collection there is another specimen of *S. lobatum* (No. 2564), from Escape Bay, South Andaman Island.

Stereum scytale, Berk., Hook. Journ. Bot. 3rd series, vol. vi. p. 170.—Pegu, Karen Hills, Bookee ridges, 5000–6000 feet. No. 2618. Pegu, Yomah. No. 3504.

Plate 19. figs. 8, 9, and 10. Fig. 8, the under side; figs. 9 and 10, the upper side of different plants: natural size.

This species was found by Drs. Hooker and Thomson in the Khasia mountains, and by Capt. (now General) Strachey in the Western Himalayas.

S. adustum, Lev. Ann. d. Sc. Nat. (1844), 3rd series, vol. ii. p. 213.—Southern Yomah, Pegu. No. 2602.

This is more properly a *Hymenochæte*.

S. papyrinum, Mont. Sylloge, p. 178.—Pegu, Timeokee, Evergreen Forests. No. 2623.

S. medicum, n. sp. Effusum, resupinatum, tenuissimum, margine subhirsuto; *hymenio* inæquali in prominentiis rotundis elevato, fusco-tabacino, subvelutino.—Sikkim, 5000–6000 feet. No. 2582.

This is a very curious production: the pileus is very thin, but the plants grow together in a stratified mass, the mass having exactly the appearance of being composed of thin layers of tobacco. It is used by the Lepchas in medicine, and has a native name.

Plate 20. figs. 9 and 10. Fig. 9, a portion (about half) of a plant; fig. 10, a section: natural size.

S. cyathiforme, n. sp. Cyathiforme, extrinsecus hirsutum, margine inflexo; *hymenio* lævi ad marginem cyathi pallide umbrino, basin versus rubro-fusco.—Pegu, Karen Hills, Bookee ridges, 5000–6000 feet. No. 2619.

Plate 21. fig. 1. Plants, natural size.

This is a very pretty plant, looking like a *Crucibulum* without sporangia.

Corticium violaceo-lividum, Fr. Epicr. p. 564.—Pegu, Yomah. No. 3476.

C. lævigatum, Fr. Epicr. p. 565.—Pegu, Yomah. No. 3507.

C. Mougeotii, Fr. Epicr. p. 558.—Sikkim Himalaya, Phalloot, on dead trees, 11,000–12,000 feet. No. 2571.

Guepinia ramosa, n. sp. Cæspitosa, simplex vel ramosa; *ramis* apice bifurcatis vel cristatis; *hymenio* aurantiaco; *stipite* subtus cinerascente.—Arracan, Kolodyne valley, on old wood. No. 2044. Howrah district, on old logs. No. 2640.

Plate 21. figs. 2 and 3. Plants, natural size.

Varying from $\frac{1}{4}$ to 1 inch in height, and from the simple forms of fig. 3 to the ramose state of fig. 2.

CLAVARIEI.

Calocera viscosa, Fr. Epicr. p. 581.—Seebpore, Lower Bengal. No. 2196.

Typhula fuscipes, Fr. Epicr. p. 586.

A specimen of this species occurs with No. 2567 (*Polyporus versicolor*).

TREMELLINI.

Tremella foliacea, P. Fr. Syst. Myc. vol. ii. p. 212.—Sikkim Himalaya, on shrubs, 10,000 feet. No. 2580.

Hinneola auricula Judæ, Fr. Hym. Eur. p. 695.—Nakawa, Evergreen Forests, Tonkyeghat. No. 2591.

H. auricula Canis, Fr. Syst. Myc. vol. ii. p. 222 (sub *Exidia*).—Pegu, Northern Yomah, on logs. No. 2615.

NIDULARIACEI.

Cyathus intermedius, Mont. Sylloge, p. 284.—Seebpore, Lower Bengal. No. 2198.

This plant agrees very well with Montagne's species, but it is not striate within. I do not observe the blackness in the substance of the sporangia noticed by Montagne; but this feature probably depends upon age.

LYCOPERDACEI.

Lycoperdon gemmatum, Fr. Syst. Myc. vol. iii. p. 36.—Sikkim Himalaya, 7000–8000 feet. No. 2576.

Spores globose, nearly 0·0002 inch. No. 2581, also from Sikkim Himalaya, 9000–10,000 feet, and No. 2653, from the Botanic Garden, Calcutta (in bamboo-thickets amongst dead bamboo remains), may be forms of *L. gemmatum*, Fr.; but there are no notes, and dried *Lycoperdons* are most difficult to determine.

L. pusillum, Fr. Syst. Myc. vol. iii. p. 33.—Lower Pegu, Kayosoo Choung, in elephant-grass jungles. No. 2630.

L. brasiliense, Fr. Syst. Myc. vol. iii. p. 40.—Pegu, Nakawa, Evergreen Forests, Tonkyeghat. No. 2635.

The specimens are, unfortunately, in very imperfect condition; but the peridium is membranous and punctate, the flocci broad and lax, and it grows on wood. It seems to agree sufficiently well with Fries's species. It is accompanied by *Hypoxylon marginatum*, Schw.

TRICHODERMACEI.

Trichocoma paradoxum, Jungh. Sikkim Himalaya, 6000–7000 feet. On mossy dead stems. No. 2585.

MYXOGASTRES.

Trichia pyriformis, Hoffm. On wood, with No. 2585 (*Trichocoma paradoxum*).

Arcyria umbrina, Fr.—Pellowa, Evergreen Forests, Tonkyeghat, Pegu. No. 2626.

HELVELLACEI.

Peziza aurantia, Pers. Fr. S. M. ii. p. 49.—Sikkim, great road, on earth. No. 2578.

P. rutilans, Fr. S. M. ii. p. 68.—Junction of the Choungmenal Choung and Tonkyeghat rivers. On mud banks. No. 2587.

Helotium citrinum, Fr. *Peziza citrina*, Fr. S. M. ii. p. 131.—Sikkim Himalaya, 5000–7000 feet. On rotten wood. No. 2583.

SPOROCYBACEI.

STILBUM INCONSPICUUM, n. sp. Solitarium vel cæspitosum, minutissimum; *capitulo* subgloboso, albido; *stipite* badio, deorsum leviter incrassato; *sporis* ellipticis, nucleo excentrico ornatis, 0·0002 unc. longis.—Seebpore, Lower Bengal. No. 2197.

S. ERYTHOCEPHALUM, Dittm. var.—On dead bamboo-stems, Botanic Garden, Calcutta, rainy season. No. 2639.

This plant hardly differs from *S. erythrocephalum*, Dittm.; but the stem is only very delicately pilose, with silky adpressed hairs.

SPHÆRIACEI.

XYLARIA DIGITATA, Grev. *Sphæria digitata*, Fr. S. M. ii. p. 326.—Botanic Garden, Calcutta. On moist logs. No. 1791.

X. TABACINA, Kickx.—Sikkim Himalaya, 7000–8000 feet. On old fallen trees. No. 2575.

X. GUYANENSIS, Mont. Sylloge, p. 202.—Tonkyeghat, Evergreen Forests, Pegu. No. 2625.

X. POLYMORPHA, Grev. *Sphæria polymorpha*, Fr. S. M. ii. p. 326.—Botanic Garden, Calcutta. On old logs in the shade, rainy season. No. 2659.

X. HYPOXYLON, Grev. *Sphæria hypoxylon*, Fr. S. M. ii. p. 327.—Arracan, Baronga Island, on old tree-stumps. No. 2046. Botanic Garden, Calcutta, on old logs, rainy season. No. 2657.

X. KURZIANA, n. sp. Solitaria vel cæspitosa, vel etiam connata, $\frac{1}{4}$–1 unc. longa; *capite* castaneo subhemisphærico, peritheciis prominentibus scabro; *sporidiis* nigro-fuscis, amygdaloideis, 0·0006–0·0007 unc. longis.—On brick-laid paths where fire had been burnt. Botanic Garden, Calcutta, rainy season. No. 2650.

Plate 21. fig. 8. Plants, natural size.

The dried plants required to be moistened to bring out the colour, which is a chestnut-brown. Mr. Kurz describes them as yellow at first and then brown. There is another *Xylaria* in the collection (No. 1783, from the Calcutta Botanic Garden), which seems to be the same as No. 2650. The habitat, viz. brick-laid soil upon which fires had been burnt, is somewhat peculiar for a *Xylaria*.

X. FLAGELLIFORMIS, n. sp. Solitaria vel cæspitosa, simplex vel furcata, flagelliformis, colore carneo; *peritheciis* —— ?—On earth, Sittang valley, along the base of the Yomah range, Pegu. No. 3485.

Plate 21. fig. 5. Plants, natural size.

X. MUTABILIS, n. sp. Solitaria vel cæspitosa vel connata, simplex vel ramosa, vel cristata; *stipite* nigro, rugoso, interdum profunde sepulto; *capite* elongato, vegetante carneo, sicco pallide umbrino, ostiolis nigris prominentibus scabro; *sporidiis* uniseriatis, nigro-fuscis, irregularibus (reniformibus, subellipticis vel subglobosis), minutissimis, vix 0·0001 unciæ attinentibus.—On brick-laid paths in the Botanic Garden, Calcutta. Very common in the rainy season. No. 1790.

Plate 21. figs. 10 and 11. Plants in different states, natural size.

This plant is remarkable for its irregular growth, the small size of its sporidia, and the

densely crowded state of the asci, which are often difficult to distinguish. I do not know any species of *Xylaria* with similar fructification.

HYPOXYLON SUBORBICULARE, Welw. & Curr. Trans. Linn. Soc. vol. xxvi. p. 281.—On old logs, Botanic Garden, Calcutta. No. 1809.

Mr. Kurz's specimens exhibit in section a browner and more corky substance than the typical *H. suborbiculare*; but I see no reason to doubt the identity of the plants. The difference is probably due to age.

H. CONCENTRICUM, Bolt. On old wood, Botanic Garden, Calcutta. No. 1810.

H. MARGINATUM, Schw. This species occurs (as above mentioned) upon the wood to which *Lycoperdon brasiliense* was attached.

DIATRYPE RUGOSA, n. sp. Irregularis; *stromate* rugoso vel depresso et marginato, intra et extra nigro; *peritheciis* in stromate sepultis, plus minus biserialibus; *sporidiis* irregularibus, globosis, ellipticis vel pyriformibus, 0·0005–0·0006 unc. longis.

On hard wood. Yomah, Pegu. No. 3471.

The stroma in this species occurs in minute rounded patches, sometimes it is prominent and rugose, sometimes depressed, with a margin, and then (under a lens) looking very like a *Patellaria*.

HYPOCREA VARIABILIS, n. sp. Statu juniore placentiformis, disco vel umbone concentrico ornata, colore citrino; statu adulto subglobosa vel irregularis, rugosa, colore umbrino; *sporidiis* ——.

Hab. On living leaves of bamboo, Yomah, Pegu. No. 3480.

Plate 21. figs. 6 and 7. Fig. 6, part of a leaf with plants, natural size; fig. 7, a plant, magnified.

SPHÆRIA PHASELINA, Mont. Sylloge, p. 239.

Hab. Nakawa, Evergreen Forests, Tonkyeghat, Pegu.

S. SUBLIMBATA, D. R. et Mont. Fl. Alg. p. 498; Sylloge, p. 228.

Apparently on stems of *Thysanolæna acarifera*, Kambala toung, top.

MICROPELTIS APPLANATA, Mont. Sylloge, p. 245.

On Girroniera leaves, Mangrove Bay, South Andaman Island. No. 2565.

FUMAGO SALICINA, Tul. Sel. Fung. Carp. vol. ii. p. 280.

On *Sphenodesma erycibordes*, Pz., Wa-choung, Yomah, Pegu. No. 3482.

NECTRIA EUGENIÆ, n. sp. *Peritheciis* pallide citrinis, tomentosis, in stromate concolori collocatis vel ejusdem marginem amplectentibus; *sporidiis* —— ?

On dead leaves of *Eugenia*. Yomah, Pegu. No. 3479.

This is a very pretty species. The perithecia for the most part are seated round the base of the stroma, the colour of which is rather darker than that of the perithecia.

GRAPHIOLA PHŒNICIS, Poit.—On leaves of *Phœnix paludosa*. Calcutta. No. 1744.

The systematic position of this curious plant has not yet been satisfactorily determined. Some years ago I examined with great care some specimens kindly furnished to me by the late Sir William Hooker, and the results of my observations were published in the Microscopical Journal in 1859 (1st series, vol. vii. p. 225). My conclusions, however, do not coincide with those of Montagne, whose account of the plant is to be found in the 'Annales des Sciences Naturelles,' 4th series, vol. xii. p. 188.

J. N. Fitch, del. et lith.

DESCRIPTION OF THE PLATES.

All the figures except fig. 7, Plate 21, are drawn to the natural size.

Plate 19.

Fig. 1. *Polyporus cinereo-fuscus,* n. sp.

Figs. 2 and 3. *Polyporus Splitbergeri,* Mont. Fig. 2, the under side; fig. 3, the upper side.

Figs. 4 and 5. *Lentinus cæspitosus,* n. sp. Fig. 4, a group of plants; fig. 5, a single plant.

Figs. 6 and 7. *Polyporus incertus,* n. sp. Fig. 6, a portion (rather more than half) of a plant; fig. 7, a section.

Figs. 8, 9, and 10. *Stereum scytale,* Berk. Fig. 8, the under side; figs. 9 and 10, the upper side of different plants.

Figs. 11 and 12. *Polyporus brunneo-pictus,* Berk., var. Fig. 11, the under side; fig. 12, the upper side.

Fig. 13. *Polyporus crassipes,* n. sp.

Figs. 14 and 15. *Lentinus irregularis,* n. sp.

Plate 20.

Figs. 1, 2, and 8. *Polyporus xerophyllaceus,* Berk.

Figs. 3, 4, and 7. *Hexagonia Kurzi,* n. sp. Figs. 3 and 7, the upper side; fig. 4, the under side of different plants.

Figs. 5 and 6. *Polyporus rubidus,* Berk. Fig. 5, upper side; fig. 6, under side.

Figs. 9 and 10. *Stereum medicum,* n. sp. Fig. 9, a portion (about half) of a plant; fig. 10, a section.

Fig. 11. *Lentinus Kurzianus,* n. sp.

Plate 21.

Fig. 1. *Stereum cyathiforme,* n. sp.

Figs. 2 and 3. *Guepinia ramosa,* n. sp.

Fig. 4. *Trametes umbrinus,* n. sp.

Fig. 5. *Xylaria flagelliformis,* n. sp. Plants, natural size.

Figs. 6 and 7. *Hypocrea variabilis,* n. sp. Fig. 6, part of a leaf with plants, natural size; fig. 7, a plant magnified.

Fig. 8. *Xylaria Kurziana,* n. sp.

Fig. 9. *Thelephora pusilla,* n. sp.

Figs. 10 and 11. *Xylaria mutabilis,* n. sp. Plants in different states. In some of the specimens, notably in the large specimen on the right of fig. 11, fragments of brick remain attached to the bases of the plants.

VI. *Preliminary Note on the rate of Growth of the Female Flower-stalk of* Vallisneria spiralis, Linn. *By* Alfred W. Bennett, *M.A., B.Sc., F.L.S., Lecturer on Botany at St. Thomas's Hospital.*

Read November 4th, 1875.

Although the extraordinary rapidity of growth of the peduncle of the female flower of *Vallisneria spiralis* (probably one of the most remarkable instances to be found in the vegetable kingdom) appears to be familiar to botanists, I have been unable to find any record of actual measurements. The present communication to the Society I prefer to call a "Preliminary Note," inasmuch as a much more extensive series of experiments than I have at present had the opportunity of making will be required before the subject can be considered exhausted.

The object of the great length attained by the female flower-stalk is well known. The flower is by this means brought to the surface of the water in which it grows, which I should infer, from the length it attains (though I do not recollect any exact record of this), to be from three to four feet. It is there fertilized by the pollen supplied by the male flower, which, growing submerged on a short peduncle, breaks off from it and rises to the surface, where it floats about until the pollen meets with a female flower, the latter after impregnation being again carried, by the spiral coiling of the peduncle, beneath the surface, where it ripens its seeds.

The first memoir, as far as I have been able to trace, of the structure of *Vallisneria* is by E. J. Quekett, "Observations connected with the Anatomy and Physiology of *Vallisneria spiralis*," in the first and only volume of the 'London Physiological Journal' for 1843. The mode of fertilization and the phenomena of rotation within the cells of the leaves are here described; and the description appears to be the basis of the ordinary accounts found in works on descriptive botany. A far more minute and accurate account of the structure of the plant is by Chatin, in his 'Mémoire sur le *Vallisneria spiralis*, Linn., considéré dans son organographie, sa végétation, son organogénie, son anatomie, sa tératologie, et sa physiologie,' 1855. The author of this memoir points out the singular error into which previous writers have fallen, in describing the peduncle of the female flower as originally coiled up spirally and unrolling towards the period of impregnation, an error repeated by Richard, Turpin, and even by Grenier and Godron in their 'Flore de France,' and by nearly all subsequent writers, whether scientific or popular, and forming the text of one of Erasmus Darwin's most poetical images in his 'Loves of the Flowers.' Chatin states, and with perfect correctness, that "la hampe des fleurs femelles, d'abord droite, ne se déroule jamais." Neither of these authors, however, gives any details on the special subject of this paper.

The first flower noticed on the plants growing in my aquarium, where the water is about 8 inches deep, was on July 19th of the present year, when the total length of the

peduncle was 26 in., lying in several long coils on the surface. I am almost certain that the whole of this growth, at all events in excess of the 8 in. which would have brought the flower-bud to the surface, had taken place within the preceding 48 hours. At 10 o'clock the next morning the peduncle was again measured, and had attained the extraordinary length of 38 in., or an increase of 12 in. in 24 hours. At 4 P.M. it measured 41 in.; at 9 A.M. on the 21st $42\frac{1}{4}$; and at 10 A.M on the 22nd it had attained its ultimate length of 43 inches. The window in which the aquarium was placed had a south-west aspect; but the climatal conditions were by no means favourable to rapid growth, the temperature being rather low, the sun scarcely visible during the whole time, and the rainfall excessive. Lest it should be thought that this is the result of an error of observation, I may mention that Mr. W. W. Reeves, the Secretary of the Microscopical Society, informs me in a note that he has observed an even greater rapidity of growth than this. I do not know whether any other instance is known of a single internode attaining a length of over $3\frac{1}{2}$ feet. This flower was never fertilized (there being at that time no male plant in my aquarium), but remained open, and the stigmas in an apparently receptive condition, nine days longer, till July 31st, when I left home. During this time no actual recoiling of the peduncle had taken place, though it displayed a strongly marked waviness.

It did not occur to me, until the flower-stalk had nearly completed its growth, that it would be interesting, in accordance with the plan proposed by Prof. Sachs, to ascertain in which portion of the flower-stalk the main portion of this rapid increase took place, though a few measurements which I did make convinced me that the apical portion was that in which there was the greatest activity.

I was unable to renew my observations before the latter part of September, in which interval a large number of female flowers had appeared. The one on which the most complete series of observations was made was first observed on Sept. 21st, at 10 A.M., when the apex of the flower-bud was 5 in. below the surface of the water, or the flower-bud and peduncle measured together 3 in. In two days and a half, or by 4 P.M. on the 24th, the peduncle had reached the length of 10·7 inches, or, when straightened, the base of the unopened flower-bud was 2·7 inches above the water, the bud, enveloped in its spathe, being 0·5 in. in length. The following were the successive measurements:—

			inches.	Increase.
Peduncle and bud	Sept. 21st,	10 A.M.	3	
,,	22nd,	10 A.M.	4·75	1·75
,,		12 noon	5	·25
,,		2 P.M.	5·2	·2
,,		8 P.M.	5·5	·3
,,		10 P.M.	5·75	·25
,,	23rd,	9 A.M.	7·25	1·5
,,		12 noon	7·6	·35
,,		3 P.M.	8·0	·4
Peduncle only	Sept. 23rd,	6 P.M.	8·0	·5
,,		10 P.M.	8·4	·4
,,	24th,	8.30 A.M.	10·0	1·6
,,		4 P.M.	10·7	·7

During the three portions of days constituting this period, the growth was at the rate respectively of 1·75, 2·5, and 3·25 in. in twenty-four hours.

At this stage it seemed possible to measure the rate of growth of different zones of that portion of the flower-stalk which, when straightened, was exposed above the surface. As, however, neither of the "auxanometers," or instruments for measuring growth, described by Sachs in his 'Text-book' can be used for weak stems which do not naturally stand erect, the only available mode appeared to be to mark off at intervals of time measured lengths from the base of the flower-bud. This was done (but necessarily, from my engagements, at very unequal intervals) with black varnish, each length of one inch being marked off as it rose (when straightened) above the surface of the water, and indicated successively as A, B, C, &c., any fraction of an inch remaining over being added to the subaqueous portion. The following table exhibits the result, neither the final length attained nor the rapidity of growth being so great as in July, as, indeed, might have been expected.

	A	B	C	D	E	F	G	H	I	K	L	M	Subaq.	Total.	Incr.
Sept. 24th, 4 P.M.	1·0	1·0	..	..	..	..	..	..	..	..	..	..	8·7	10·7	
10 P.M.	1·0	1·0	1·0	..	..	..	..	..	..	..	..	..	8·0	11·0	·3
25th, 8 A.M.	1·1	1·1	1·1	1·0	..	..	..	..	..	..	..	..	8·1	12·4	1·4
27th, 10 A.M.	2·25	2·5	1·8	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	..	8·8	23·35	10·95
2.30 P.M.	2·6	2·75	1·9	1·15	1·15	1·1	1·05	1·05	1·0	1·0	1·0	1·0	8·1	24·85	1·5
10 P.M.	2·75	2·9	2·0	1·15	1·15	1·15	1·1	1·1	1·1	1·1	1·1	1·05	8·5	26·15	1·3
28th, 9 A.M.	2·9	3·0	2·1	1·15	1·15	1·15	1·15	1·1	1·1	1·1	1·1	1·1	8·75	26·85	·7
10 P.M.	3·1	3·1	2·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	8·75	27·45	·6
29th, 9 A.M.	3·25	3·23	2·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	8·8	27·75	·3
10 P.M.	3·25	3·25	2·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	1·15	8·8	27·75	·0

The general results arrived at are that between 4 P.M. on Sept. 24th and 9 A.M. on Sept. 29th the flower-stalk had increased in length from 10·7 to 27·75 in., the two zones immediately beneath the flower-bud from 2 in. to 6·5 in. This latter portion had increased during this period 225 per cent., the remainder of the flower-stalk 144 per cent. of its original length.

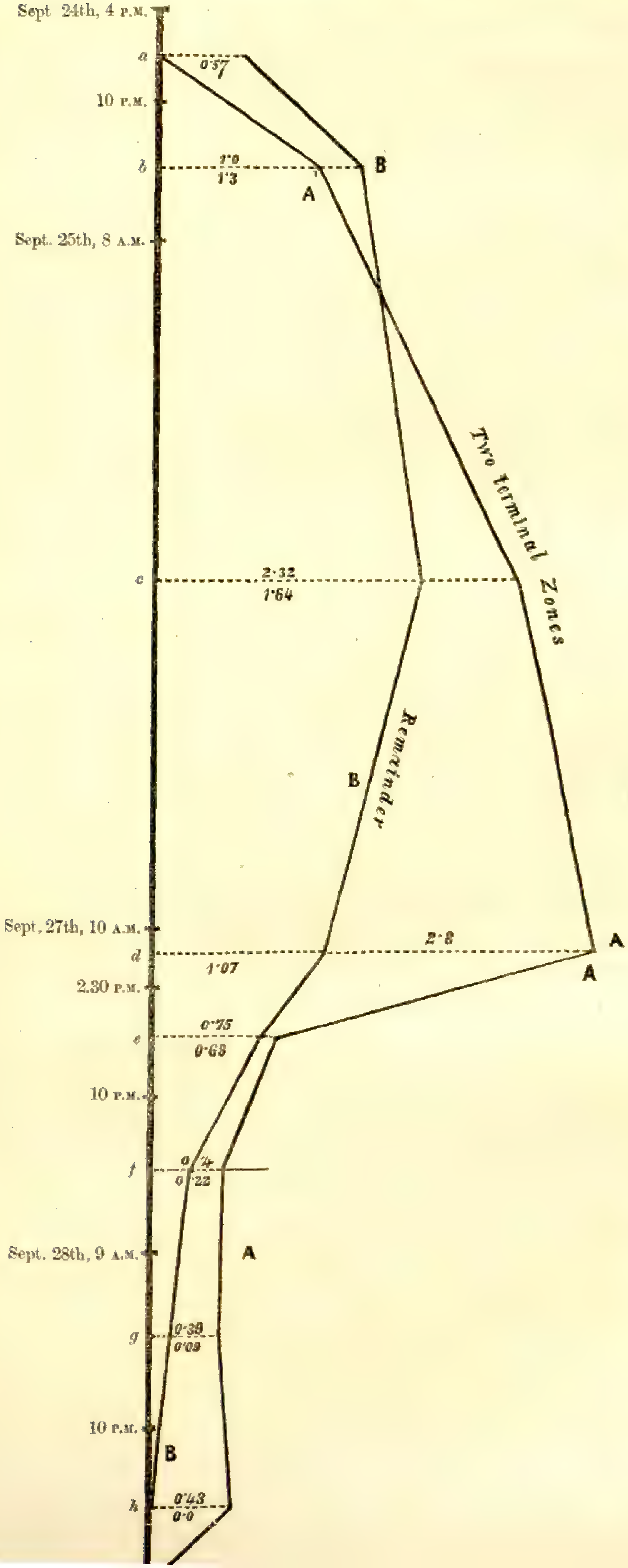
The term "Energy of Growth" of any particular part or zone of a plant is defined by Sachs ('Text-book,' p. 741) as "the power of that particular zone to attain a definite length." In the case of the stem of a plant consisting of a number of internodes, the measurements of Sachs, Pfeffer, and others show that the greatest energy of growth is generally displayed by an internode situated at some distance from the terminal bud, the energy of growth decreasing in the successive internodes, both towards the apex and towards the base of the stem. Similar careful measurements do not appear to have been made of the relative energy of growth of different portions of the same internode. In the case of the greatly elongated internode of *Vallisneria*, the maximum energy would appear to be very near the apex, the total energy of growth of the two terminal zones being to that of the remaining portion as 225 to 144, or nearly as 3 to 2. The energy would appear also, as far as any conclusion can be drawn from my few measurements, to decrease towards the base. For, dividing the portion of the flower-stalk excluding the

two terminal zones again into two parts, the uppermost of these (C–L) increased between 10 A.M. on Sept. 27th and 9 A.M. on Sept. 29th, from 9·8 to 11·35 in., or 15·8; the lowermost of them from 8·8 to 9·95 in., or only 13 per cent of its original length.

In calculating what Sachs terms the "Grand Curve of Growth" of the plant *, I have pursued a somewhat different plan to that adopted by this high authority. In his 'Text-book' (p. 737) he gives the following instructions for the construction of such a curve:—"If the increments of growth during successive equal times are drawn as ordinates, with the intervals of time as abscissæ, a curve will be obtained which, starting from the axis of abscissæ, reaches a maximum of elevation and returns again to the axis." In constructing these curves, it appeared to me that results of greater value would be obtained if, instead of the actual increment for any given time, the proportionate increase in relation to the length at the commencement of the interval were taken as the ordinate. By this means it seems to me that the energy of growth of each particular portion of the stem at any particular time will be represented by the altitude of the curve. Thus, supposing a stem increases during two successive equal intervals of time from 4 to 5 and from 5 to 6 inches, the energy of growth will not be equal to the two intervals, but will be less in the latter interval in the proportion of 4 to 5; inasmuch as it will have increased during the former interval 25 per cent., during the latter interval only 20 per cent. of its length at the commencement of that interval. It will be evident that though my grand curves of growth will agree with Prof. Sachs's in their general features, they will differ in minor particulars, and will in general be less abrupt. In constructing the curves from the data already given, I have first of all divided the increment during each interval of time by the length at the commencement of the interval, in order to get the proportionate increase as above indicated, and then the result by the number of hours in the interval, in order to reduce the times to a uniformity, the length of the intervals between the observations varying greatly, owing to my engagements. It is obviously, then, indifferent on what scale the curve is constructed, *i. e.* what is taken as the unit of measurement. In the diagram which accompanies this (p. 137), each unit of 1 inch on the ordinates represents an increase of 1 per cent. per hour; while an inch on the line of abscissæ represents a period of 12 hours. In accordance with Prof. Sachs's plan I have placed each ordinate in the centre of the abscissa to which it belongs. The two accompanying curves have thus been obtained, one exhibiting the variation of the energy of growth for the two terminal portions, the other for the remainder of the flower-stalk. The general result is seen to be that the terminal portion exhibits a considerably greater energy during the whole of the time with the exception of the first few hours.

A second series of observations was made on another flower-stalk; but I have not thought it worth while to record the results in detail, in consequence of an accidental injury (to which the slender and delicate stems are extremely liable when undergoing measurement), which both retarded the growth and caused it to be somewhat irregular. The curves constructed in the same manner showed a striking resemblance to those in the previous instances, but with two abrupt depressions caused by the injury referred to.

* See 'Arbeiten des botanischen Instituts in Würzburg,' 1873, Heft 2, t. i.



Curves of Growth of the two terminal zones and the remaining portion of the female flower-stalk of *Vallisneria spiralis*, Linn.

A. Grand curve of growth of the two terminal zones; B. Grand curve of growth of the remaining portion of flower-stalk. On the line of abscissæ every inch represents a period of 12 hours; on the ordinates every inch represents a growth at the rate of 1 per cent. per hour. The figures above each ordinate express the growth of curve A, those below the ordinate the growth of curve B on this notation. The ordinates are erected from the centres of the several periods of time, *a*, *b* *c*, &c.

This flower-bud was first observed at 10 A.M. on Sept. 22nd, when its apex was 1 inch below the surface. By 9 A.M. on the 23rd, the total length of the peduncle was 9·75 in.; at 8.30 A.M. on the 24th, 13·95 in.; 8.30 A.M. on the 25th, 16·6 in.; 10 A.M. on the 27th, 19·0 in.; and at 9 A.M. on the 28th it had reached its ultimate length of 19·75 in. Two terminal zones, together 1·6 in. in length, were first marked off at 6 P.M. on Sept. 23rd, and had finally, at 9 A.M. on Sept. 28th, attained the length of 3·6 inches, or had increased 125 per cent. on the original length. The remainder of the stem had during the same time increased from 10 in. to 16·15 in. or 61·5 per cent. The total energy of growth of the terminal portion was therefore in this instance just double that of the remainder; but the latter had undoubtedly been checked by the accidental injury.

The flower-bud, when it first rose to the surface of the water in the aquarium, was ·5 in. in length, and closely enveloped in its spathe, from which it shortly afterwards gradually emerged, but did not open until the growth of the flower-stalk was nearly completed, when it had attained a length of ·75 in. The flower remains open floating on the surface for weeks, with the stigmas in an apparently receptive condition. By the time its growth is completed the flower-stalk has become very wavy, but does not coil up in shallow water when the flowers are unimpregnated.

The only record I have been able to find of observations on the rate of growth of different portions of the same internode is by J. Münter, in the first volume of the 'Botanische Zeitung' for 1843. He here lays down the general law that in the internodes of dicotyledonous plants the energy of growth, or, as he terms it, the *vis procreativa*, increases from below upwards, or may be described as centrifugal. This result he found most strikingly displayed in the peduncle and pedicels of *Pelargonium*, the only observations, I believe, which have hitherto been made on different parts of individual internodes *. It is interesting to compare this with the law of growth of stems taken as a whole, which is thus laid down by Sachs ('Text-book,' p. 740):—"As it is usual for several contiguous internodes of stems to be growing at the same time, and the maximum rapidity of growth occurs, according to circumstances, in the 2nd, 3rd, 4th, or 5th internode beneath the bud, the region of most rapid growth is at a considerable distance from the apex of the stem, and especially when the internodes attain a considerable length and several are growing at the same time. In roots, on the other hand, the maximum rapidity of growth occurs much nearer the *punctum vegetationis*, usually at a distance of only a few millimetres." It would appear, therefore, as if the phenomena of growth in the flower-stalk of *Vallisneria* exhibit a closer similarity to those of the roots than of the aerial stems of terrestrial plants.

* See also the reference to Münter's observations on the Hyacinth, *postea*, p. 143.

VII. *On the Growth of the Flower-stalk of the Hyacinth.* By ALFRED W. BENNETT, *M.A., B.Sc., F.L.S., Lecturer on Botany at St. Thomas's Hospital.*

Read March 16th, 1876.

IN a paper which I had the honour of reading before the Society at its meeting on November 4th, 1875, I gave some details in respect of the remarkably rapid growth of the flower-stalk of the female flower of *Vallisneria spiralis*. The general results arrived at were that the greatest "Energy of Growth" was displayed by the apical portion of the peduncle or that immediately beneath the flower-bud, the energy apparently decreasing regularly towards the base of the flower-stalk. As this appeared to be opposed to the law stated by Sachs and others to govern the rate of growth of the different successive internodes of an aerial stem, I was anxious to ascertain how far it was in accord with the relative rapidity of growth of different portions of a single elongated aerial internode. For this purpose I have taken the earliest opportunity during the present spring of measuring the growth of the common peduncle of the inflorescence of the Hyacinth, with the following results in two specimens, one grown in a hyacinth-glass, the other in soil in a pot.

Specimen A, *grown in a hyacinth-glass.*

This was first measured at noon on Feb. 23rd, when the peduncle, with a total length of 1·25 in., was divided into two equal portions of 0·625 in. At 10 A.M. on the 26th, when it had increased to 1·55 in., each of the two sections was again divided, the length of the four portions, proceeding from above downwards, being 0·35, 0·4, 0·4, and 0·4 in. Measurements were made twice and sometimes three times a day; and it was soon evident that the energy of growth of these different portions was very unequal. By 10 P.M. on Feb. 29th each of the three uppermost portions was still only 0·5 in. long, whilst the lowest had increased to 1·0 in. From this time the increased rapidity of growth of the lowest portion was still more marked. By 10 P.M. on March 5th the lengths were respectively 0·9, 0·9, 0·85, and 2·35 in., and at 10 P.M. on March 11th, when the growth had finally ceased, the measurements were 1·15, 1·0, 1·0, and 3·45 in., making a total of 6·6 in. The following is a complete table of the measurements:—

	A	B	C	D	Total.	Increase.
Feb. 26th, 10 A.M.	·35	·4	·4	·4	1·55	
12 noon	·35	·4	·4	·45	1·6	·05
10 P.M.	·35	·4	·4	·5	1·65	·05
27th, 1 P.M.	·4	·4	·4	·55	1·75	·1
10 P.M.	·4	·4	·4	·55	1·75	·0
28th, 10 A.M.	·45	·4	·4	·65	1·9	·15
3 P.M.	·45	·4	·4	·7	1·95	·05

	A	B	C	D	Total.	Increase.
Feb. 28th, 10 P.M.	·45	·45	·4	·75	2·05	·1
29th, 10 A.M.	·5	·45	·45	·8	2·2	·15
3 P.M.	·5	·5	·45	·95	2·4	·2
10 P.M.	·5	·5	·5	1·0	2·5	·1
March 1st, 10 A.M.	·55	·55	·5	1·2	2·8	·3
10 P.M.	·6	·55	·5	1·25	2·9	·1
2nd, 10 A.M.	·65	·6	·55	1·3	3·1	·2
6 P.M.	·7	·65	·55	1·35	3·25	·15
3rd, 10 A.M.	·75	·65	·6	1·5	3·5	·25
3 P.M.	·75	·7	·6	1·7	3·75	·25
10 P.M.	·8	·7	·6	1·9	4·0	·25
4th, 10 A.M.	·8	·75	·75	2·2	4·5	·5
10 P.M.	·85	·8	·8	2·3	4·75	·25
5th, 10 A.M.	·85	·8	·8	2·3	4·75	·0
10 P.M.	·9	·9	·85	2·35	5·0	·25
6th, 10 A.M.	·95	·9	·9	2·5	5·25	·25
10 P.M.	1·0	·9	·9	2·7	5·5	·25
7th, 10 A.M.	1·0	·9	·9	2·75	5·55	·05
10 P.M.	1·0	·9	·95	2·9	5·75	·2
8th, 10 A.M.	1·05	·9	1·0	3·0	6·0	·25
10 P.M.	1·1	1·0	1·0	3·15	6·25	·25
9th, 10 A.M.	1·1	1·0	1·0	3·2	6·3	·05
11 P.M.	1·15	1·0	1·0	3·25	6·4	·1
10th, 10 A.M.	1·15	1·0	1·0	3·4	6·55	·15
10 P.M.	1·15	1·0	1·0	3·45	6·6	·05
11th, 10 A.M.	1·15	1·0	1·0	3·45	6·6	·0

It will be seen from the above table that by far the greatest total energy of growth was displayed by the lowest of the four segments, which increased during the twelve days between Feb. 26th and March 10th from 0·4 to 3·45 in., or 762·5 per cent. of its original length. The next greatest energy, but at a great interval, was exhibited by the apical section, which increased from 0·35 to 1·15, or 228 per cent., while the two central portions exhibited the least activity, increasing only from 0·4 to 1·0, or 150 per cent. of their original length. Dividing the peduncle into an upper and a lower half, and constructing the "Curve of Growth" in the same manner as those given for *Vallisneria* (p. 137), the accompanying diagram (Curve A) represents the results diagrammatically. On the ordinates, again, 1 in. represents a growth of 1 per cent. per hour on the length at the commencement of each interval; but each inch on the line of abscissæ represents a period, not of 12 but of 24 hours. In order, therefore, to compare the curve of growth of the Hyacinth with that of *Vallisneria*, the former ought to be flattened out so as to occupy twice the space. It will be seen that the rate of growth was subject to great variations on different days, dependent, no doubt, on the temperature and other causes. Making the division between day and night at 10 A.M. and 10 P.M., the growth was nearly equally divided between them, the 5 inches growth between Feb. 26th and March 10th being accounted for by about 2·65 in the daytime and 2·35 at night.

Specimen A.

The thicker curve represents the Energy of Growth of Sections C & D, the thinner curve the energy of growth of Sections A & B; the figures above the ordinates represent the percentage growth per hour during the respective intervals of the former, those below the ordinates that of the latter curve. On the line of abscissæ every inch represents a period of 24 hours.

Specimen B.

The thicker curve represents the Energy of Growth of Section D, the thinner curve the energy of growth of Sections A, B, & C; the figures above the ordinates represent the percentage growth per hour during the respective intervals of the former, those below the ordinates that of the latter curve. On the line of abscissæ every inch represents a period of 24 hours.

Specimen B, *grown in a pot.*

In the second example, the evidence was still more conclusive that the growth of the peduncle is mainly basilar. On Feb. 26th, the flower-stalk, then an inch in length, was divided into two equal portions of 0·5 in. On the next day, when it had increased to 1·1 in., the lowest zone of 0·1 in. was marked off separately. By 10 P.M. on Feb. 29th this lowest zone (C + D) had increased to 0·7 in., or by 600 per cent. of its original length, while the two uppermost zones were still respectively only 0·55 and 0·5 in. long. The lowest zone was then again divided into two portions, the upper one being 0·5 and the lower 0·2 in. long. By 10 P.M. on March 3rd the lengths of the four zones, commencing from the top, were 0·8, 0·8, 0·75, and 0·75 in., giving a total of 3·1 in. At 10 P.M. on the 7th, the total length of 6·5 in. was distributed thus:—1·6, 1·5, 1·25, and 2·15 in.; and at 10 A.M. on the 13th, when the final length of 8·2 inches had been attained, the measurements were respectively 2·2, 1·75, 1·5, and 2·75 in. The following is the complete table:—

	A	B	C	D	Total.	Increase.
Feb. 26th, 9 A.M.	·5	·5	..	..	1·0	
10 P.M.	·5	·5	..	..	1·0	·0
27th, 1 P.M.	·5	·55	..	..	1·05	·05
10 P.M.	·5	·5	·1	..	1·1	·05
28th, 9 A.M.	·5	·5	·2	..	1·2	·1
3 P.M.	·5	·5	·2	..	1·2	·0
10 P.M.	·5	·5	·2	..	1·2	·0
29th, 9 A.M.	·55	·5	·45	..	1·5	·3
10 P.M.	·55	·5	·5	·2	1·75	·25
March 1st, 10 A.M.	·55	·55	·5	·3	1·9	·15
10 P.M.	·6	·55	·55	·3	2·0	·1
2nd, 9 A.M.	·6	·6	·55	·4	2·15	·15
6 P.M.	·65	·6	·55	·5	2·3	·15
3rd, 10 A.M.	·65	·65	·65	·6	2·55	·25
3 P.M.	·75	·75	·65	·65	2·8	·25
10 P.M.	·8	·8	·75	·75	3·1	·3
4th, 10 A.M.	·9	·9	·8	1·1	3·7	·6
10 P.M.	·9	·9	·85	1·25	3·9	·2
5th, 10 A.M.	1·0	1·0	1·0	1·25	4·25	·35
10 P.M.	1·05	1·1	1·1	1·25	4·5	·25
6th, 10 A.M.	1·2	1·25	1·1	1·55	5·1	·6
10 P.M.	1·35	1·3	1·2	1·75	5·6	·5
7th, 10 A.M.	1·5	1·5	1·25	1·85	6·1	·5
10 P.M.	1·6	1·5	1·25	2·15	6·5	·4
8th, 10 A.M.	1·65	1·5	1·25	2·15	6·55	·05
10 P.M.	1·7	1·55	1·35	2·15	6·75	·2
9th, 10 A.M.	1·85	1·6	1·4	2·15	7·0	·25
11 P.M.	2·0	1·65	1·4	2·35	7·4	·4
10th, 10 A.M.	2·0	1·65	1·4	2·45	7·5	·1
10 P.M.	2·0	1·65	1·4	2·45	7·5	·0
11th, 10 A.M.	2·0	1·65	1·45	2·55	7·65	·15
12th, 10 A.M.	2·15	1·7	1·5	2·75	8·1	·45
10 P.M.	2·15	1·7	1·5	2.75	8·1	·0
13th, 10 A.M.	2·2	1·75	1·5	2·75	8·2	·1
10 P.M.	2·2	1·75	1·5	2·75	8·2	·0

Starting from the measurement at 10 P.M. on Feb. 27th, the lowest of the three zones, which then measured 0·1 in., had increased by March 13th so as to make up the two zones C & D together 4·25 in., or 4150 per cent. of its original length, while the remainder had only increased from 1·0 to 3·95, or at the rate of 295 per cent. Again, starting from 10 P.M. on March 29th, when the four zones were first marked off, the ultimate increase of the lowest was from 0·2 to 2·75 in., or 1275 per cent.; the next greatest energy was displayed by the uppermost, which increased from 0·55 to 2·2, or just 300 per cent.; next came the second zone from the top, which showed an increase from 0·5 to 1·75, or 250 per cent.; and finally the third from the top, showing an increase from 0·5 to 1·5 in., or exactly 200 per cent. The curve B in the accompanying diagram (p. 141) illustrates the total energy of growth of Section D as compared with that of Sections A, B, and C taken together, the former being, as in the case of the previous curve, in excess during almost the whole period of growth. The rate of growth was again subject to great irregularities, which will be seen to correspond to a considerable extent to those of curve A, and were no doubt attributable mainly to changes in temperature. Making the division between day and night as before at 10 A.M. and 10 P.M., the total amount of growth was again not very different in the two; but instead of being, as in the previous case, slightly in favour of the day, was rather more decidedly in favour of the night; of the 6·5 in. growth from Feb. 29th to March 13th, 3 inches was by day, and 3·5 inches by night.

It will therefore be seen that, as far as these observations on the relative growth of different portions of the same internode go, they are entirely in accord with the statement of Prof. Sachs (*vide ante*, p. 135), in regard to that of different internodes on the same branch, that the maximum energy of growth is exhibited at a period considerably below the *punctum vegetationis*, though it is here much nearer the base than in the cases measured by Sachs. This brings out into still stronger relief the opposite phenomenon displayed by the elongated submerged flower-stalk of *Vallisneria*, the energy of growth of which is manifested mainly in the apical portion. The elongation of the peduncle of the Hyacinth continues considerably after the complete expansion of the flowers, until the lowest in the raceme begin to fade.

These observations differ in several points from those on the flower-stalk of the Hyacinth recorded by Münter in the 'Botanische Zeitung' for 1843, Feb. 24; but as he gives no measurements, I cannot think that these latter are of very great weight. He describes its growth as not centrifugal, like that of most flower-stalks, but centripetal; that is, it ceases to grow first near the flower and finally at the base. It will be seen that my two experiments (and I think the care with which the measurements were made precludes any possibility of mistake) agree in this, that while the energy of growth is greatest in the basal portion, the apical portion continues to grow for very nearly or quite as long. The growth of the flower-stalk of *Pelargonium* he describes, on the other hand, as centrifugal, the growth of each zone ceasing before the one next above it.

With regard to the relative amount of growth by day and by night, Münter also gives no measurements, but states that in the daytime the plant grows at first five times, then four times, and then three times stronger than by night. This differs materially from

the general law as stated by Sachs ('Text-book,' English ed. p. 749 *et seq.*), that "the plant will, according to circumstances, sometimes grow more quickly by day, sometimes by night, without exhibiting any exactly recurrent periodicity," the difference, however, being never so great as that stated by Münter. My own observations are more in accordance with this.

Since writing the above, my attention has been called by Prof. Sachs to a series of papers by Reinke in the 'Botanische Zeitung' for the present year, on the phenomena of growth of stems. His experiments were made entirely on the flower-stems of Endogens, chiefly *Juncus, Scirpus,* and *Narcissus*; but the only point that bears on the present inquiry is the statement that "the part of *Narcissus* in which growth takes place is entirely beneath the earth, and of the rushes within the leaf-sheath, all the parts which rise above the earth having already completed their growth." Unfortunately Reinke does not give the measurements on which he founds this statement; and, if correct, it presents a singular want of harmony with the law of growth exhibited in the Hyacinth. The point seems to deserve further careful investigation.

A very few measurements which I made on the leaves of the Hyacinth indicate that the increase in length in them takes place *entirely* in the basal portion, at least after they have attained a considerable length (see Sachs, 'Text-book,' English ed. p. 137). Whether, however, the cell-division is carried on actually beneath the surface of the soil, as stated by Reinke to be the case in the stem of *Narcissus*, I am unable to say.

VIII. *New British Lichens.* *By the Rev.* W. A. Leighton, *B.A. Camb., F.L.S., F.B.S.Ed.*

(Plate XXII.)

Read February 3rd, 1876.

Verrucaria myriospora, Leight. *Pale yellowish*, filmy, very thin, effuse or determinate by a pale brown watery line; *apothecia shining black*, moderate in size, numerous, round or oblong, often difformed by confluence, sessile and conspicuous, *hemispherico-subpapillate*; epithecium a very minute pore in the apex of the papilla; *perithecium dimidiate, spreading at the base, carbonaceous*; asci narrow, leneari-clavate; paraphyses few, very slender and delicate; *spores innumerable*, colourless, very minute, oblong or lineari-oblong, *simple*.

On young oaks, Kylemore and Doughruagh, co. Galway (October 1875), *Mr. Larbalestier*.

A singular and peculiar species, differing in its general aspect and its innumerable very minute spores from any described species. Spores ·003 mm. long, ·0015 mm. broad. Spermogonia numerous, minute, roundish or clavate, black like the apothecia. Spermatia large, linear, arcuate. Gelatina hymenia I—.

Verrucaria succina, Leight. *Thallus fuscescent*, thin, effuse, scarcely if at all surrounding the base of the apothecia; *apothecia amber-colour*, numerous, large, *hemispherico-conical, papillate*; *perithecium amber-colour throughout, dimidiate, spreading at the base*; epithecium a minute pore in the apex of the papilla; paraphyses very delicate and slender; asci lineari-clavate; *spores* 8, colourless, *broadly fusiform, 7-septate,* large.

On moist rocks near the lake, Kylemore, co. Galway, very rare, *Mr. Larbalestier* (1875).

The apothecia, when wetted, became of a beautiful transparent amber-colour. Spores ·046 mm. long, ·008 mm. broad. No spermogonia detected. Iodine has very slight if any reaction on the asci and spores. Its nearest ally would seem to be *V. illinita*, Nyl.; but that species differs in having a whitish thallus, nigricant apothecia, the perithecium colourless in the lower part, and fuscous in the upper part, and iodine turning the asci and spores of a dirty deep brown, and is also a corticolar lichen. *V. succina* differs also in the size and colour of the apothecia from *V. chlorotica* (Ach.), which is consociate on the same rock, and which has also smaller 3-septate fusiform spores.

Lecidea subdiluta, Leight. Thallus of a *dark dirty sea-green colour*, thin, effuse, *continuous*, very slightly rimulose; *apothecia pale, waxy*, minute, *elevato-sessile*; *epithecium pale brown*, plane or concave, *surrounded by a thickish, pale, waxy, elevated*

margin; *hypothecium colourless,* or only very slightly yellowish at the very base; paraphyses indistinct, conglutinate, apices brown; *spores* 8, *colourless, oblong,* 1-*septate,* somewhat constricted in the middle.

On maritime rocks, Boulay Bay, Jersey, *Mr. Larbalestier* (May 1872).

Spores ·019 mm. long, ·0085 mm. broad. No spermogonia detected. Medulla I−. Gelatina hymenia I−.

This very interesting lichen was sent to me for determination by Mr. Larbalestier immediately on its discovery in 1872; and I at once saw that it was a new and distinct species, and named it *L. subdiluta,* from the general external resemblance of the apothecia to those of *L. diluta* (Pers.). This name I communicated to Mr. Larbalestier (*in litt.*) in 1872; and he subsequently deposited specimens with that name in Herb. Brit. Mus. and in several private herbaria. The lichen was subsequently shown by Mr. Larbalestier to Dr. Nylander, who, as Mr. Larbalestier informed me (*in litt.*), thought it "a seaside anomalous state of *L. prosechoides,* Nyl., and not worth distinguishing," which of course it is not. Since then Dr. Nylander has changed his opinion, and now describes it as a "species notabilis" in the 'Flora,' 1875, p. 442, under the name of *Lecanora jejuna,* Nyl. My name *L. subdiluta,* Leight., claims priority.

Lecidea advenula, Leight. Thallus *obsolete*; *apothecia nigro-fuscous,* minute, round, plane or subconvex, with a thin margin soon obliterated, *brownish within*; paraphyses indistinct, conglutinate, apices large, nigro-fuscous; *hypothecium thickish, nigro-fuscous*; *spores* 8, *nigro-fuscous, oblong,* 1-*septate.*

Parasitic on *Pertusaria sulphurea* (K yellow, C orange-red).

On rocks, Llanbedrog, near Pwllheli, North Wales, 1874. Very rare.

A very singular lichen, not scattered uniformly over the matrix thallus, but occurring only on blackened patches formed by some conglomerate spherical brown alga at intervals over the thallus. Gelatina hymenia I−. Spores ·024 mm. long, ·013 mm. broad.

Melaspilea vermifera, Leight. Thallus *obsolete*; *apothecia black,* very minute, *irregularly angulari-oblong,* imbedded in the cortical layer, *when dry plane and surrounded by a minute upraised jagged margin* of the cortical layer, when wet plano-convex, the margin obliterated; hymenium pale; paraphyses very delicate and slender, apices pale; asci lineari-obovate; *spores innumerable,* colourless, *arranged spirally* in the ascus, cylindrico-fusiform, pointed and arcuate at each end, *vermiform,* 1-septate.

Parasitic on the thallus and apothecia of *Variolaria discoidea,* T. & B. (*Pertusaria globulifera,* Turn.).

On oaks, Trefriw, North Wales, 1874. Rare. Gelatina hymenia I−. Spores ·022 mm. long, ·002 mm. broad.

Arthonia punctilliformis, Leight. Thallus a mere film; *ardellæ nigro-fuscous, excessively minute,* not larger than a pin's point, irregularly roundish, convex, scattered,

internally brown; asci pyriform; paraphyses none; *spores* 8, *pale fuscescent, oblongo-clavate, 1-septate,* large.

On holly, Trefriw, North Wales, 1874, very rare. Spores ·029 mm. long, ·0135 mm. broad.

DESCRIPTION OF PLATE XXII.

Fig. 1. *Verrucaria myriospora,* nat. size.
2. Same lichen, enlarged.
3. Section of perithecium.
4. Asci.
5. Spores, magnified 1200 times.
6. Spermogonia.
7. Spermatia, magnified 330 times.
8. *Verrucaria succina,* its apothecium and perithecium, magnified.
9. Apothecium as seen from above, showing papilla and epithecium.
10. Structure of perithecium.
11. Spore, magnified 1200 times.
12. Paraphyses.
13. *Lecidea subdiluta,* nat. size.
14. Apothecium, magnified to show its peculiar elevato-sessile character.

Fig. 15. Section of apothecium.
16. Spores, magnified 1200 times.
17. *Lecidea advenula,* nat. size.
18. Enlarged representation of the same.
19. Section of apothecium.
20. Spores, magnified 1200 times.
21. *Melaspilea vermifera*: apothecia, magnified, as seen from above in dry state.
22. Apothecia wetted, magnified.
23. Paraphyses.
24. Ascus.
25. Spores, magnified 1200 times.
26. *Arthonia punctilliformis,* nat. size.
27. Ascus.
28. Spore, magnified 1200 times.

Lecidea advenula

Arthonia punctilliformis

C. Perjean ad.
M. & N. Hanhart imp.

NEW BRITISH LICHENS

IX. *On the Hygroscopic Mechanism by which certain Seeds are enabled to bury themselves in the Ground.* By FRANCIS DARWIN, *M.B., F.L.S.*

(PLATE XXIII.)

Read March 16, 1876.

THE object of this paper is to describe the hygroscopic mechanism by which certain seeds are enabled to bury themselves in the ground. This phenomenon as it occurs in the Geraniaceæ has already been described by Hanstein *, and again by G. Roux † in the case of *Erodium*; lastly, Asa Gray ‡ briefly points out the power of burying themselves possessed by the carpels of some of the Western American species of this genus. After describing the process, he adds, " It is the same with the grain and awn of *Stipa*." I may mention that the latter note only appeared after I had completed my researches on this subject.

The species on which my observations have been made are *Stipa pennata*, *Avena elatior*, *Heteropogon contortus* (Bombay), *Heteropogon* (*Andropogon*) *melanocarpus*, (Florida), *Androscepia arundinacea*, *Anthesteria ciliata* § (Khasia), *Anemone montana* (from Switzerland).

It seems to me an extremely remarkable fact that the curious power of burying themselves should be exhibited by plants belonging to several distinct orders, and inhabiting various parts of the world; and that the mechanism should be essentially the same in all of them is even more remarkable.

My observations have been chiefly confined to *Stipa*; a short description of the caryopsis of this plant will explain the general method of action common to all the other fruits observed by me.

Fig. 1 represents the seed || of *Stipa pennata*. It terminates inferiorly in a sharp strong oblique point (*p*) ¶, armed with a dense plume of barb-like hairs; $v\,k_1\,k_2\,f$ is the strong woody awn, of which the lower vertical part (v) is strongly twisted on its own axis, the appearance of the strands of a rope being given by the ribs r and r, fig. 9 (and seen in section in figs. 11 & 12), which run spirally up the awn. Above, the awn terminates in a long untwisted portion (f), bearing a series of beautiful hairs, giving its well-known feathery aspect: when the seed is dry this portion extends nearly horizontally outwards. The twisted and vertical part (v) is separated from the feathery part (f) by a curious double bend; the two angles thus formed I call the lower and the upper knee (k_1 and k_2).

* Sitzungsberichte d. Niederrhein. Gesell. Bonn, 1868. See Sachs, 'Botany,' Eng. Trans. p. 841, for abstract.

† Annales de la Soc. Bot. de Lyon, 1873.

‡ Silliman's Journal, Feb. 1876, p. 158.

§ Dr. Hooker most kindly supplied me with specimens of the four last-mentioned species.

|| The use of this expression in place of the strict botanical term may perhaps be allowed me, on account of its greater convenience.

¶ Said to be capable of injuring the intestines of animals which feed on the grass (Hooker's Trans. of Decaisne and Le Maout, p. 892).

The hygroscopic action of the awn may be shown by holding the seed so that the twisted axis is vertical; on wetting the awn, the feathery portion will revolve, describing a circle in a horizontal plane; the vertical part untwisting, and its strand-like ribs becoming more and more oblique (*i. e.* making a smaller angle with the axis of the awn), until at last, when the awn is thoroughly wet, it shows no signs of torsion, and the two ribs run parallel to its axis down two of its opposite surfaces. As the awn untwists, the two knees, k_1 and k_2, are obliterated (k_1 disappearing first); by this means the feather is brought into line with the twisting part, and the awn forms a long straight pliable rod, pointing vertically upwards. It follows from this, that though the end of the feather begins (at the commencement of the wetting) by describing a circle, it ultimately describes a helix.

As the awn dries again, the action is exactly reversed: the axis becomes twisted; the two knees reappear; and the feather becomes again subhorizontal.

It was this remarkable property exhibited by *Stipa* of untwisting and twisting in response to alternations of moisture and drought, which convinced my father and myself that the whole structure must be adapted to some very definite end. We concluded that this object must be that of forcing the seed into the ground (in the manner to be immediately described). The sequel gives the result of my investigation of this point.

If in the above-described experiment the feather is prevented from revolving while the seed is left free, the untwisting of the vertical part of the awn will make the seed rotate on its axis. In consequence of the untwisting, the vertical part of the awn from the knee (k_1) to the tip of the seed becomes longer by about 7 per cent. Therefore, if we fix a dry *Stipa*-awn in a vertical position, the seed resting freely on the ground, and the feather being prevented from revolving, on wetting the awn the seed will rotate and will be pressed against the ground. But this requires that the expansion of the awn shall not be permitted to take place in an upward direction; *i. e.* the upper extremity must be fixed to give a *point d'appui*, from which the expansion may take effect in pressing the lower extremity against the soil.

In describing the untwisting of the axis it was stated that the angles k_1 and k_2 increase as the awn absorbs water, until the whole awn is converted into a straight rod. Now in the same way that, by interfering with its movements, the rotation of the feather is transferred to the seed, so by preventing the feather from rising to its full extent the tendency of the awn to become straight results in increased pressure of the point against the ground. The seed now resembles a brad-awl in exhibiting vertical pressure on a revolving point. In order that this action may take place in its entirety, three *points d'appui* are theoretically needed, although one is practically capable of performing the duties of all. The first is required, to transfer the rotation from the feather to the seed; the second, to force the expansion resulting from the untwisting of the awn to take effect downwards; the third, to convert the tendency of the awn to straighten itself into pressure of the seed against the ground. It is evident that if an awn be placed vertically, the seed resting on the ground, so that the feather can neither rotate nor describe any great angle in a vertical plane, all the required conditions will be fulfilled.

How can this be effected in a state of nature? Prof. Hildebrand has pointed

out * that the long feathery awn of *Stipa* serves as a "Verbreitungsmittel," or means of distribution. It is found that seeds dropped from a height of a few feet usually preserve a nearly vertical position, and strike the ground with their point. Moreover, if they are allowed to fall among low vegetation they are caught by the knees (k_1 k_2) or by the feather, and are fixed in a more or less oblique position, the seed resting on the ground. Many seeds would no doubt escape being entangled; and many others would be caught in unsuitable positions—suspended in the air, for instance, or making too acute an angle with the ground, or resting on some hard impenetrable body. Neverthelsss many seeds are undoubtedly caught and held fast in suitable positions. The great length of the feather (nearly 30 cm.) would render entanglement in low vegetation an easy matter; and when a seed is once entangled the hairs serve to hold it fast and prevent the wind blowing it away.

In order to ascertain what would occur under these circumstances, I made experiments of the following kind :—A vessel being filled with dry sand or light soil, two upright sticks were fixed at about a centimetre apart; and these were connected at the height of 8 or 9 cm. from the surface of the soil by a cross pin, a second one being fixed 2 or 3 cm. higher up. The *Stipa*-seed is then placed with its point resting on the soil, and its feathery awn passed through the loophole between the two supports and the two cross pins. The whole is now placed under a bell glass lined with wet blotting-paper. This is better than wetting the awn directly; for in touching it with a wet brush it is possible to push it into the soil without being aware of it, and in syringing it the soil may become too much wetted. In order to dry the awn it is merely necessary to remove the glass; thus by alternations of dryness and moisture the awn is made to twist and untwist, just as it would under the changing hygrometric conditions of dew and sunshine in a state of nature. The amount buried may then be measured with a pair of compasses. It is very important to estimate the amounts buried, by measuring from the surface of the soil to the top of the *seed*, and not to any marked point in the awn; for in the latter case the measurements will be obviously inaccurate, owing to the lengthening and shortening of the awn.

All the movements of the awn are far more conveniently studied when the seed is fixed and the feather free to rotate; and in taking the times of rotations &c. I have found it best always to employ immersion in water in preference to exposing the awn to a damp atmosphere; for by the former means a constant amount of moisture is secured, and in nature the awn must be frequently exposed to an amount of moisture practically equivalent to immersion.

A dry *Stipa*-awn plunged into water at the temperature of the room began to rotate within a second of its immersion, and untwisted at the rate given in the following table :—

* Verbreitungsmittel der Gramineen-Früchte, Bot. Zeit. 1872, No. 49.

Turn.	Completed in	Turn.	Completed in
	M. S.		M. S.
No. 1	2 30	No. 6	1 30
2	2 0	7	1 45
3	1 45	8	2 10
4	1 35	9	3 20
5	1 25	10	

Thus the rate increases up to the 5th revolution, and then diminishes quickly.

The lower bend or knee is obliterated in from 20′ to 30′; the awn becomes completely untwisted in from $\frac{3}{4}$ to 1 hour; in doing so it increases in length by about 7 per cent.; a well-grown awn measures from the point of the seed to this lower bend 70 mm. dry, 75 wet. The upper knee disappears in periods of time which are rather variable, and lie between two and three hours. The movement which takes place as the awn untwists or twists is a combination of two rotations: the first is that due to the torsion of the vertical portion of the awn (50–55 mm.) from the lower knee down to the seed; the other rotation is due to the torsion of the short portion (15–18 mm.) between the knees. This latter axis is carried round quite independently of its own torsion, by the torsion of the long vertical axis; thus the portion k_1 k_2 (fig. 1) describes a cone about an axis of rotation which is continuous with v; and, again, owing to the torsion of the part k_1 k_2, the feather is made to rotate, describing a figure of rotation having a line continuous with k_1 k_2 for its axis. We have seen that the feather is usually nearly horizontal when dry, and vertical when wet (the seed being held vertically in both cases); it follows that in passing from the wet to the dry state the tip of the feather does not describe a regular helix, as would be the case if there were only one bend, but a complex figure varying with the varying relations between the rotations due to the two axes v and k_1 k_2. The rotations due to the untwisting of k_1 k_2 are slow (7–13 minutes); and since but two revolutions are possible, owing to the shortness of this part, their effect is not always great on the revolutions due to the untwisting of the vertical axis, which are from 13 to 16 in number. The rotation of the awn is best studied by fixing the seed while the upper end is allowed to revolve; and by the experience gained in this way it is possible to understand what occurs in the experiments on artificial burying where the awn is fixed while the seed is free to rotate. When an awn has been placed for several hours in the damp chamber, fixed in the kind of support described, it will not always be found to have buried itself. I have often found that the point of the seed has been dragged across the soil into which it should have thrust itself; and in these cases it has happened that the seed has been pushed down over the edge of the vessel, so that it would have tended to bury itself if the soil had been of a larger area. It is this dragging motion which I believe to be produced by the torsion of the short axis between k_1 and k_2 (fig. 1); for just as, when the awn is free, irregular movements are impressed on its rotation, so the tendency to irregular rotation is transferred to the seed when the awn is fixed. In other cases the experiment is successful, and the seed is found buried to a certain depth; the sand is often found disturbed close around the point, owing, no

doubt, to the irregularity of the rotatory motion of the awn. The following measurements give the amounts buried in three cases during a single wetting:—

I.

3 P.M.—A seed of 16 mm. length, resting with its point on damp sand.
5 P.M.—14 mm. of seed projecting above soil.
9 A.M. (still wet).—10 mm. „ „
Amount buried 6 *mm.* (2 of them in 2 hours).

II.

5 P.M.—12 mm. of seed projecting.
9 A.M.— 7 mm. „ „
Amount buried 5 *mm.*

III.

11.0 A.M.—6 mm. of seed projecting.
3.15 A.M.—2 mm. „ „
Amount buried 4 *mm.*

On removing the bell glass—that is, on substituting a comparatively dry for a damp atmosphere—the awn begins at once, *i. e.* in less than one second, to twist in the opposite direction to the hands of a watch; and as the drying proceeds all the above-mentioned movements are reversed. The following are the times in which the first six revolutions were made in once instance:—

Turn.	Completed in (M. S.)	Turn.	Completed in (M. S.)
No. 1	13 0	No. 4	2 30
2	9 0	5	6 0
3	5 0	6	7 30

the movement being slow at first, then becoming quicker, and then slow again.

The lower knee (k_1) becomes perceptible in from 5 to 10 minutes, the upper knee (k_2) begins to be perceptible in from 10 to 15 minutes. The whole process of drying cannot be said to be thoroughly complete under two hours (in an ordinary room in winter); but the movement during the second hour is extremely slow, and practically almost unimportant.

When the drying-process is finished an examination of the seed will show that one of three things has occurred:—

(i.) The upward traction which results from the return of the awn to its former dry condition frequently pulls the seed out of the soil, especially if the sand used in the experiment is dry.

(ii.) The seed may, however, be able to withstand the upward traction.

(iii.) It may actually be found to be buried deeper than it was at the commencement of the drying-process.

The following measurements give the amount buried in three instances during a single drying :—

I.

6.45 P.M.—9 mm. of seed projecting above surface.
8.15 A.M.—7 mm. " "
Amount buried 2 mm.

II.

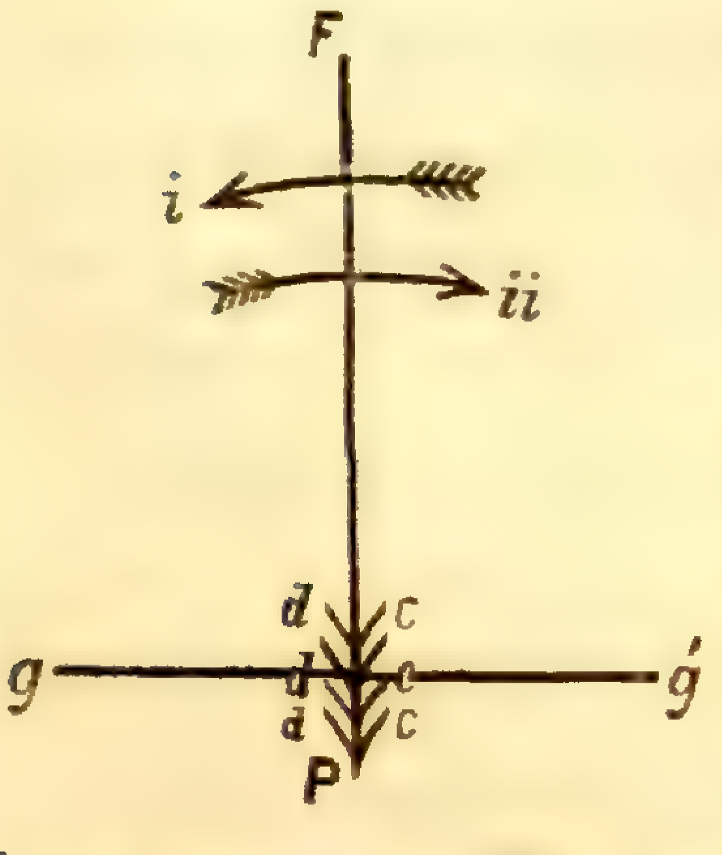
11.30 A.M.—$12\frac{1}{2}$ mm. projecting above surface.
1. 2 P.M.—10 mm. " "
Amount buried $2\frac{1}{2}$ mm.

III.

9 A.M.—10 mm. projecting above surface.
11 A.M.— 6 mm. " "
Amount buried 4 mm.

In investigating the burial of the seed caused by drying, it must first be remarked that the plume of hairs with which the point is armed (see figs. 1 & 7) offers but little resistance to the entrance of the seed, but tends to prevent its withdrawal. The bare sharp point (p, figs. 1 & 7) is about $\frac{1}{3}$ mm. in length; the hairs which form the plume are graduated, the smallest ($\frac{1}{4}$ mm.) being the nearest to the point, so that they tend to preserve the smallest amounts buried during the wetting process. Moreover the length of the whole plume, measured from the extreme tip of the seed, is only about 4 mm.; and as we have seen that as much as 5 mm. may be buried in one wetting, it is quite conceivable that the seed can resist the uprooting tendency of the drying process. To understand how it can actually be buried deeper, we must examine more closely the act of rotation during drying.

A vertical rod, which is fixed at the upper extremity, will, as it twists on its axis, cause a simple rotation of its lower free extremity. But if the upper or fixed end is not vertically above the lower or revolving end, *i. e.* if the rod is curved, there will, I believe, be a tendency for the rotation to take place about the line joining the upper and lower ends of the rod. The movement imparted to the point will then resemble the circular rocking motion which is employed when a stick is being thrust into the ground. Given pressure from above, a rotating vertical rod will make a cylindrical hole of continually increasing depth; but if this pressure is removed, it will merely continue to rotate in the hole already made. But in the case of a *Stipa*-awn (a *curved* rod twisting on its axis), even when the pressure from above is removed the rocking* tends to continue the burying process. The point of the seed may be compared to a barbed point, like that in the woodcut.



The point P is supposed to be thrust into the ground, $g\,g'$ giving the level of the soil.

* Whatever may be the explanation of this movement, it certainly occurs.

The free end F is now supposed to rock backwards and forwards, describing arcs alternately in directions *i* & *i i*, in the plane of the paper and about the point P. When F moves in direction *i* the barbs *d d d* will offer little resistance, whereas the barbs *c c c* will in fact act like fulcra, and will enable P to be forced deeper into the ground. On the movement being reversed, this action will be reversed also, *d d d* giving the fulcra, and P being again buried deeper. Although the tendency of a *Stipa*-awn, on drying, is to move (not backwards and forwards in one plane, but) so as to describe a cone, yet I believe the above-described process is essentially what occurs in *Stipa*; for the seed is revolving in soil of densities varying at different points, so that it moves not regularly, but by jerks; moreover the plume is rather more developed on two of the opposite surfaces of the seed than on the intermediate regions, and the point is obliquely set on. In observing the process of drying, I have often seen a distinct rocking movement as the awn attempted to rotate and was continually forced back again. All their aberrations from a structure and from a rotation of mathematical regularity must favour the levering or wriggling movement of which the diagram in the woodcut gives the essential action.

In describing the manner in which the seed of *Erodium* is buried during drying, Hanstein does not enter into any of the above considerations as to a rocking movement &c.; he merely says that "the lower part of the awn begins to contract into narrow spiral coils, causing the cone (*i. e.* seed) to turn on its axis and penetrate the ground; and the erect hairs on it, which point upwards, retain it there like grappling-hooks"*.

It has now been shown by what means the seed of *Stipa* is buried, both as it untwists and also as it returns to a state of torsion. By a combination of these two processes, the awn is thrust into the soil to such a depth as to cover up the seed completely. Thus, in an experiment, in three wettings and three dryings 28 mm. was buried in dry sand: the ordinary length of a seed is 17 mm.; so that this is amply sufficient. In another experiment a seed of 16 mm. length was completely buried in three wettings and three dryings. Another seed, which I entangled in the branches of a low bush, and left out of doors for eight days, had buried itself to a depth of 31 mm., impaling a piece of rotten leaf on its way. Mr. Farrer informs me that the *Stipa*-seeds which blow away from the parent plants succeed in burying themselves in his garden. The question of what advantage it is to the plant to bury its seeds will be discussed in the sequel.

Before passing on to describe the arrangement of structure of which the hygroscopic mechanism consists, I shall give a brief account of the phenomena exhibited by the *Stipa*-awn, considered merely as mechanical actions, and with no reference to the biological conditions in which they occur in Nature.

A simple instrument was made for me by my brother Horace: a piece of *Stipa*-awn, about 5 cm. in length, was employed, taking care to avoid either of the knees (k_1 or k_2). The awn is fixed at one end, and at the other bears a light index, fitted to travel round a clock-face as the awn twists or untwists; the bearing of the awn is so managed that the whole of it can be immersed in different fluids. The *Stipa*-awn is hygroscopically ex-

* Sachs, p. 841, Eng. Transl. (a perfectly correct abstract of the original).

tremely sensitive *; but as we shall see that it is also very sensitive to changes of temperature, a purely hygroscopic result is not so strikingly demonstrable as one due to a change in temperature and in moisture combined. Thus, breathing on the *Stipa*-hygroscope, held even at arm's length, or bringing the warm and moist hand near the awn, causes distinct movements of the index.

De Luc showed † that water has no *special* virtue in causing the expansion of hygroscopic bodies, and that other fluids can perform the office of filling out the molecular interstices. If the *Stipa*-hygroscope is allowed to dry in the air of an ordinary room, and is then plunged into absolute alcohol, the index shows, by moving in the "dry" direction, that water is being removed from the awn; after a time the alcohol itself is absorbed, and the movement of the index is reversed. On removing the instrument, the index moves in the "wet" direction, in consequence, I suppose, of the absorption of water by the alcohol; ultimately, however, the alcohol evaporates, and the movement of the index is reversed.

The effects of temperature on the awn are extremely curious, and agree with those observed by De Luc ‡: he found that a rise in temperature affects hygroscopic bodies in the same way as increased moisture, whereas a fall in temperature acts like dryness. With a *Stipa*-hygroscope the experiment is a pretty one; it is allowed to remain in warm water until the index comes to rest; if it is then removed, and plunged into cold water, the index gives a quick start through 90° or more in the direction of drying (*i.e.* against the hands of a watch). On replacing it in the warm water a rapid movement in the opposite, or "wet," direction takes place. The experiment may be performed in another way. If the hygroscope is placed in the current of hot air from a lamp, the rise in temperature tends to make the index move in the wet direction; but it also *dries* it, and therefore tends to make it rotate in the opposite direction: the struggle is made obvious by the fluttering motion of the index. The ultimate result is the victory of the "drying" rotation. The coincidence in the effects of heat and moisture accounts for the extreme sensitiveness of the *Stipa*-hygroscope to being breathed on.

The first theory which suggests itself to account for the effects of temperature is, that as an increase in the quantity of water in the molecular interstices makes the awn untwist, an increase in bulk of the water already permeating the tissues acts in the same manner. In support of this view my brother Horace showed that it cannot be due to *air* contained in the tissues; for the index does not move when the receiver of an air-pump under which it is placed is exhausted, or when the air is readmitted. In performing this experiment we immersed the hygroscope in oil or in mercury, to obviate the effects of the change of temperature resulting from the change of air pressure; before this precaution was taken the index moved distinctly as the air was removed or let in, although the thermometer only registered a change of 2° F.§

* It has been employed as a hygrometer (Watts, Dict. of Chemistry, iii. p. 233).

† Phil. Trans. 1791, p. 11.

‡ *Loc. cit.* p. 16.

§ The sensitiveness to changes in temperature was well exhibited by my brother, who observed that on lifting the *Stipa*-hygroscope out of water it always moved very slightly in the *cold* direction, but that this movement disappeared at the temperature of the dew-point, showing that it was due to evaporation.

My brother then suggested that if it were due to the expansion or contraction of the water contained in the tissues, the results ought to be exactly reversed when water at 4° C. was used as the higher temperature, 0° being the lower one, because water expands instead of contracting in passing from 4° to freezing-point, and therefore the *Stipa*-hygroscope ought to behave as if 0° was a higher temperature than 4°. Preliminary experiments showed that a difference of 4° is clearly indicated by the hygroscope; but, to our surprise, we found that the hygroscope behaves exactly as if water expanded in passing from 0° to 4°. We therefore concluded, like De Luc, that the effects of temperature have nothing to do with the expansion of water. He placed his hygrometer in quicklime, by which means he obtains what he calls "absolute dryness," and found that changes of temperature affected his instrument in "nearly the same" manner as when in water.

The only explanation left appears to be that the woody tissue itself expands with heat. But, from the experiments of Villari *, it appears that the expansion of dry wood with heat is *extremely* small compared with the expansion due to imbibition. I find it impossible to believe that the rapid rotation through a considerable angle is due to this cause. The following curious phenomenon negatives such a view, but must also remain quite unexplained. It will be made clear by detailing an experiment. Two vessels of water were employed, whose temperatures differed by about 63° C. In the cold water the index of the hygroscope stood at 130; on putting it into the hot water the index moved quickly to about 240 (not exactly noted), and returned slowly to 115. That is, it first makes a rapid *untwisting*, or *wet* movement, and then returns to a point on the *dry* side of its original position—that is, a point representing increased torsion of the awn; so that on moving into hot water it untwists rapidly, and then twists slowly up beyond its original degree of torsion. Exactly similar but reverse results ensue on removing the awn from hot to cold water. These experiments have been frequently repeated by my brother and by myself.

The Mechanism of Torsion.—In Sachs's 'Handbook' † the twisted growth of trees is explained by the internal parts not growing as fast as the external tissues, the unequal longitudinal tensions satisfying themselves by producing torsion. To apply this to the torsion of the *Stipa*-awn, we must suppose that, on drying, the internal parts contract more strongly than the external. This action may be imitated, as Sachs remarks, by slipping an elastic tube over a second of smaller calibre; the internal one is then stretched, the external one being left as it is, and the two are bound together in several places. On the release of the internal tube, the external one will not permit any shortening of the internal tube except by the whole system turning into an irregular helix. Hildebrand ‡ offers a similar explanation for the torsion of the awn of the "Springhafer" (*Avena sterilis*). He says that one surface of the awn contracts on drying more strongly than the opposite surface, and the awn twists on itself to satisfy the unequal tension thus produced. Hanstein § explains the torsion of the awns of the Geraniaceæ in a similar way. For a long time I concluded that some explanation of a kindred nature

* Quoted in Sachs: English Translation, p. 649.

† English Translation, 1874, p. 770.

‡ Pringsheim's Jahrb. für w. Bot. 1873, Bd. ix. "Schleuderfrüchte."

§ *Loc. cit.*

must hold good for *Stipa*. I assumed that if there existed unequal longitudinal tensions along opposite surfaces of the awn, there would be inequality of contraction or expansion in a radial direction, and that the sectional outline would alter in shape on drying. I could observe no such alteration, and found, in fact, that on swelling in water the awn increased in diameter very nearly equally in all directions. I concluded, therefore, that the inequality of expansion must be between the internal and external tissues, and not between two longitudinal halves. I saw no way of confirming or destroying this hypothesis; but I always felt a difficulty in the fact that the *Stipa*-awn is *always* twisted in one direction, whereas the above-mentioned unequal distribution of tensions would give a tendency to twist in either direction. Ultimately all theories of unequal contraction of the awn as a whole were overturned by observing that longitudinal sections and mere strips torn from the awn were capable of twisting up into precisely the same right-handed screw as the whole awn. This proved that torsion-power may reside in a combination of a few cells. The fact that a transverse section of the twisted awn of *Anemone montana* shows only broken-down tissue in the centre, convinced me that torsion is possible where the twisting-organ has *no* strongly contracting tissue in the centre. These two observations suggested that the power of torsion must reside in the individual cells composing the awn. I therefore boiled a piece of *Stipa*-awn in dilute nitric acid and chlorate of potassium; by subsequent teasing in a drop of water, the cells were isolated with great ease. The slip of glass was then held over a spirit-lamp, and a light teasing action continued, to prevent the cells adhering to the glass on drying. On examining the object under the microscope the torsion of the individual cells was beautifully seen; besides individual cells, numerous little ropes of two or three cells are seen, *all* twisted in the direction of torsion of the awn, *i. e.* that of a right-handed screw (see fig. 14).

To this observation it may be objected that the treatment with hot acid may have conferred the power of torsion on the cells. To this it may be answered, (1) that small portions, separated by *mechanical* means, exhibit torsion when dried; (2) that pieces of awn treated with boiling nitric acid and chlorate of potassium (if they are not teased into their constituent cells) undergo torsion on drying, proving that the cause of the torsion, whatever it be, is not affected by the treatment with acid.

I believe that both the internal and the external cells of the awn are capable of independent torsion; but whether this be so or not, it is certain that the small external cells exhibit the power in a far higher degree. This cleared up what had always seemed a great difficulty, viz. the instantaneous movements of the *Stipa*-hygroscope; for it removes the seat of hygroscopic action from the internal tissues to a more accessible part near the surface. In accordance with the present theory, it is found that the individual cells possess the same delicacy of action as the whole awn. I have actually seen a single cell under the microscope untwisting and twisting up again as my hand approached and was withdrawn from its neighbourhood.

Supposing it then to be granted that the cells composing the awn are capable of independent torsion, we have yet to show that the twisting of the awn as a whole will be

the result. The cells are of an elongated form, and are of course closely attached to one another, so that unless they are isolated they cannot twist on their own axis, since this would require a sliding movement between each cell and its neighbours. The following experiment demonstrates the way in which each cell satisfies its tendency to twist on its own axis.

A number of *Stipa*-awns (exclusive of feather and knees) are soaked in water, and when thoroughly untwisted are firmly tied into a cylindrical bundle or faggot. Here we have represented the state of things in an awn: each constituent awn in the bundle represents one of the cells of an awn, and, like them, tends to twist on its own axis on drying. It is found that, on drying, the bundle of awns is converted into a *rope*, its constituents passing helically round like the strands. And just in the same way the cells which make up an awn (of which the bundle of awns is a *schema*) satisfy their tendency to twist by forming a rope of cells twisted in the same direction as themselves.

If, then, we have a number of cells so connected together that they are incapable of independent torsion (and this is the case in the awn of *Stipa*), and if, further, each cell has a tendency to twist on its own axis (as we know to be the case with *Stipa*), then it cannot be doubted that the torsion of the mass of cells as a whole will be the result. That this is actually the mechanism by which the awn twists is conclusively shown by the fact that the constituent cells of the feathery non-twisting portion have *no* such power of independent torsion when isolated and dried in the manner already described.

The Bending of the Awn at the Knees (k_1 & k_2).—If we compare a section of the feather-bearing portion of the awn with a section of the twisting part, we find that the difference between them lies in this: in the twisting part the cells are all thick-walled (excepting the central ones, *c*, and two small masses, *m* & *m*, fig. 11); but in the feather all the cells are hollow, and it looks as if the central mass of thin-walled cells had increased so as to fill up the whole interior of the section. And since this thin-walled tissue is not hygroscopic in the feathery portion, we may assume that it is not so in the twisting part. Comparing a section taken low down in the awn (fig. 11) with one taken at the upper knee (fig. 13)*, we find a marked difference in the distribution of the non-hygroscopic tissue. At the upper knee the cells are passing into the hollow condition found in the feather; but this change does not attack all parts simultaneously: the small masses of non-hygroscopic tissue, *m* & *m*, have enlarged and coalesced with the central mass (*c*); and it is the cells surrounding the coalesced masses which exhibit the commencement of the loss of thickening in their walls. We may divide the section by a line *x y*, on one side of which there are many hollow cells, on the other all thick-walled cells. The twisting-power, which is already weak in the portion of the awn between the two knees, must be disappearing at k_2, since in the feather it is quite gone. When drying commences, the mass of thick-walled cells contract longitudinally; and the mass of hollow cells not being able to contract to the same extent, the awn will bend with the non-

* In the drawings of the sections, figs. 11, 12, & 13, the stratification of the cell-walls is not represented; nor are the pit-channels given, which are especially numerous in the large internal cells, and which seem to communicate with the vascular bundle in the centre.

hygroscopic half on the convex surface, and the strongly contracting cells on the concave aspect. To prove that the internal cells do contract longitudinally, it is only necessary to split an awn longitudinally; on drying, the split-off pieces bend with the internal surface concave. There can be no inherent tendency in the separate cells at k_2 to bend in the direction assumed by the awn; for a small portion severed by a longitudinal section (such as is shown by the upper dotted line, fig. 13) bends with the internal surface concave, which is in the opposite direction to that in which the whole awn bends.

The bending at the lower knee is more difficult to explain. The hollowing-out of the cells near *m* & *m* has begun even at this part of the awn: two hollow cells are shown in fig. 12; and in other sections I have found more of them occurring. In this section, again, we might draw a line which would divide the awn into a more and a less contractile half. In fact we have at the lower knee a bending-mechanism similar to that which exists at the upper knee, but with an important difference: at k_2 the torsion-power of the awn is exhausted, whereas at the lower knee this is not the case; and since the unequal longitudinal tension just described can satisfy itself by assisting the *torsion*, it does not seem evident how the *bending* of the awn is to be effected. To explain this a hitherto neglected point in the structure must be noticed. If we compare once more a section of the awn close to the seed with one taken at either of the two knees, we find that in the lower section (fig. 11) the ribs *r r*, are separated from one another by approximately equal portions of the circumference; but at the lower knee (fig. 12) the arc on the side *m m* has diminished, while the other has increased. In a wet or untwisted awn, the fact that the ribs approach one another as they pass from below upwards, gives the appearance of a very slight and elongated left-handed screw. And I believe that the approach of the ribs to one another is directly connected with the unequal arrangement of the more and less hygroscopic tissue at the knees. At the lower knee there is, moreover, a single sudden and short turn of a left-handed screw. This I call the "reverse twist," since it is in the opposite direction to that in which the awn twists in drying. The reverse twist is perfectly distinct from the ordinary hygroscopic torsion of the awn; for it is not obliterated by wetting, and is the result of the growth of the tissue into that shape. It is like a single turn of a fluted spiral column made of india-rubber, which could obviously be twisted in either direction independently of its shape. Now since the awn twists in the opposite direction to the reverse twist, the latter will be obliterated as torsion proceeds; and this is, in fact, the case: the awn is twisted both above and below the knee; but at the actual bending-place there is no torsion. When the reverse twist is obliterated, the unequal longitudinal tensions at the point k_1 are employed in producing the bend, instead of satisfying themselves in assisting the torsion. To summarize this imperfect explanation, the torsion-power satisfies itself in obliterating the reverse twist; and then the unequal tension, being brought into a longitudinal direction, satisfies itself by producing the bend.

I suspect it was the reverse twist which deceived Max Wichura*, and led him to describe the awn of *Stipa* as twisted to the right below the knee, and to the left above it.

* "On the winding of Leaves," Taylor's 'Scientific Memoirs,' May and Aug. 1853, p. 280; the original in 'Flora,' 1852, Jan. and Feb.

I have discussed the mechanism of the bend at some length, because of its extreme importance in the burying-process; for if the awn did not terminate above in a non-twisting horizontal portion, the rotation would not be transmitted to the point of the seed, neither could there be any increase of vertical pressure resulting from the straightening of the awn.

Torsion.—An explanation will now be attempted of the power of torsion which the cells possess.

It is a general property of hygroscopic tissue that the cells composing it are thick-walled. I have already pointed out the difference in this respect which exists between the hygroscopic and the non-hygroscopic tissue of the *Stipa*-awn. Hildebrand ("Schleuder-früchte") mentions the thick-walled cells composing the awn of *Avena*. We should expect therefore that the power of torsion would depend on the manner in which the cell-walls are thickened.

Before discussing my view, it will be well, first of all, to exclude any cause resembling the unequal internal and external tensions which are supposed to account for the torsion of trees; for this only shifts the difficulty one step further off, and does not account for the constancy of *direction* of torsion. We may now examine the structure of the cells which make up the hygroscopic tissue. A body which swells on imbibing water will expand equally in all directions, if the molecular interstices in which the water lies are symmetrically arranged in all directions. And a cell will have no tendency to twist if its cell-wall expands equally in all directions. Therefore, if we are to account for the torsion of a cell by the expansion or contraction of its cell-wall, we must examine the molecular structure of the wall with special reference to the distribution of the capacity for absorbing water. The well-known researches of Nägeli * are directed to this very point.

He there shows that the cell-wall is composed of parallel lamellæ of alternate degrees of density and refractive indices. The first series of lamellæ are seen in transverse sections of elongated woody cells, as concentric shells, alternately light and dark, and fitting inside each other. This appearance is well known as stratification or "*Schichtung*." The other systems are essentially of the same nature, but are not so well marked. They give rise to the appearances known as "*Streifung*" or striation; these are series of parallel lines, alternately light and dark, traversing the surface of the cell, and are in reality the edges of parallel lamellæ of alternate densities. There are usually two systems of parallel lamellæ; and they may be inclined to the axis of the cell at almost any angle. Very frequently the two systems wind spirally round the axis in opposite directions. Now according to Hofmeister †, when the tissue of the cell-wall expands during imbibition, it is chiefly due to the swelling of the less-dense striæ; and we have seen that these striæ are spirally arranged; therefore we are led to expect that the imbibition of water will result in some kind of spiral tension: and spiral tension will result in torsion—just as when a string is fastened to one end of a rod, and is coiled spirally round it, and the free end is pulled, the rod will tend to rotate on its axis. And since there are two systems of spiral striation, the tension due to one system must be stronger than that

* Münchener Sitzungsb. 1864, May & July.

† Lehre v. d. Pflanzenzelle, (1867) p. 197.

due to the other, if any tendency of the cell to twist in one direction more than in the other is to result. Nägeli has shown* that imbibition does lead to the torsion of a cell on its axis when one system of striation is more pronounced than the opposite. Fig. 10 is copied from his paper already quoted†: *a* shows a cotton-wool fibre in extremely dilute sulphuric acid; *b* is the same fibre in somewhat more concentrated acid. The first treatment merely brings out the striæ more clearly; the stronger acid causes the fibre to swell and to twist on its axis. The importance of these figures is this: in *a* it may be seen that the direction of the striation changes in the lower half of the fibre; and in *b* it is seen that the direction of the torsion changes precisely where the direction of the striation does; not only do cotton-wool fibres twist on the intense imbibition caused by acid, but, as I find, on the intense *abstraction* of water caused by strong drying. From these facts we must conclude that the striation of the cells is the cause of the torsion of fibres of cotton wool.

The elongated cells of the *Stipa*-awn present a close analogy with cotton-wool fibres; not only do they twist on drying, but also, as a result of the great swelling caused by maceration in strong Schultz's solution, they undergo torsion in the opposite direction.

From all these considerations, I cannot resist the conclusion that the torsion of the cells in the *Stipa*-awn is a direct consequence of unequal contraction of the cell-wall due to the striation of the membrane. I have found the investigation of the molecular structure of the cells in the *Stipa*-awn too difficult a task to be included in the present research; I believe, however, I may say that the cells are obliquely and spirally striated, and that one system is more strongly developed than the opposite.

Both Nägeli and Hofmeister give explanations of the ultimate mechanism of the torsion of cells; but in my present need of clear anatomical details it would be useless to apply their explanations to *Stipa*-cells.

I now pass on to describe the remaining seeds or fruits observed by me.

Avena elatior.

Professor Hildebrand has described the hygroscopic awn of *Avena sterilis*, both as to the mechanism of the twist and the adaptation of the hygroscopic torsion as a means of distribution‡.

Fig. 4 shows the awn of *Avena elatior* (the empty glumes having been removed). It will be seen that, supposing the fruit to be held vertically, we have, just as in *Stipa*, a vertical twisted part of the awn, and a more or less horizontal part which is not twisted. In *Avena sterilis*, according to Hildebrand§, the spikelet contains two fertile flowers, and therefore two bent awns. He describes how, in drying, the pressure of the rotating part of the awn against the ground causes the fruit to be projected into the air ("ein Stück fortgeschleudert wird")‖.

* Münchener Sitzungsb. 1864, July, p. 124.

† Tab. i. figs. 8 & 9.

‡ Pringsheim's Jahrb. *loc. cit.*; and "Verbreitungsmittel der Gramineen-Früchte," Bot. Zeitung, no. 49, 1872.

§ Schleuderfrüchte, Separatabd. p. 14.

‖ This curious property has gained for it in Germany the popular name of "Springhafer" (*Hildebrand*). I have met with a curious mention of the wild oat in the 'The Young Man's Companion, or Arithmetic made easy,' 1727:—

He also describes a method of progression by turning over and over, and a kind of creeping movement caused by the extension and flexion of the awns. Prof. Hildebrand suggests that possibly the more important function of the twisted and bent awns of *Avena* and other grasses may be similar to that of *Erodium*, *i. e.* to bury the seeds in the ground. From analogy with *Stipa*, and from other considerations, there can be little doubt that this surmise is correct.

The fruit of *Avena elatior*, 6 times magnified, is given in fig. 4. The vertical part of the awn (attached to the outer palea or flowering glume) is about 5 mm. in length, and is strongly twisted into a right-handed screw of about 4 turns. It follows that, just as in *Stipa*, the horizontal portion (6 mm. long) revolves in the direction of the hands of a watch when the awn is wetted. It is more sensitive hygroscopically than *Stipa*, and untwists very quickly (one turn in from 15″ to 30″) when placed in water, as compared with the *Stipa*-hygroscope, which makes one revolution in 2 or 3 minutes.

It will be seen that the point is blunt, and that it is covered with a plume of hairs pointing backwards as in *Stipa*; but these hairs seem to me too weak to be of much service. The horizontal portion of the awn is not feathered, but armed (as is also the twisting part) with minute reflexed barbs. I have not succeeded in observing the process of burial in *Avena*; nor has Hildebrand seen it. But I found that the seeds of a patch of wild oats growing in a ploughed field had succeeded in burying themselves. I believe that the mechanism of burial is not quite the same in *Avena* as in *Stipa*; the seed is too heavy to be held vertically, and the awn does not seem fitted for so supporting it. Moreover the specimens which I found buried were not in a situation where low herbage could have entangled their awns, but among bare lumps of clay. I presume that the point is pushed laterally against inequalities in the ground, other projections being made use of as *points d'appui*.

In explaining the mechanism of torsion in *Avena*, I am compelled, unfortunately, to differ entirely from Prof. Hildebrand. His view has been already mentioned. Against it I bring forward the arguments:—

(i.) That it does not account for the direction of torsion being constantly the same.

(ii.) That the surface which he believes to be the most contractile is on the *convex* side at the bending-point.

(iii.) The strong argument that the cells, when isolated by nitric acid and chlorate of potassium, exhibit precisely the same power of independent torsion as those of the *Stipa*-awn.

The mechanism of the knee is, I believe, the same in *Avena* as in *Stipa*. Professor Hildebrand figures a section of this awn (which is morphologically identical with that of *Stipa*) as having two cavities answering to the hollow ribs of *Stipa*, and, like them, filled with cells containing chlorophyl in the young state. In this condition the ribs make an

"The following trick is made use of when any thing in a family is lost, to make the person suspected confess the fault and restore what is lost. Take a beard of wild oat while 'tis greenish, and twist it in the shape of a little cross, giving it to the person suspected, and whose guilt they are pretty well assured of. Give also to the rest of the family little crosses, but made of different stalks, as hay and wheat; put all these in a cut apple, and the little wild oat will grow sensible of the moisture, untwisting itself and turning, to the great amazement of all the spectators."

elongated turn in the direction opposed to the hygroscopic torsion of the awn; and this elongated "reverse twist" is seen in the mature awn when untwisted by wetting. This reverse twist is the consequence of the approach of the ribs to each other as they pass from the lower part of the awn to the point of bending; and I think that, as in *Stipa*, this alteration in form is connected with the longitudinal partition of the awn into a more and a less contractile half.

HETEROPOGON MELANOCARPUS.

The general appearance of the awn of this species is shown in fig. 2. In an ordinary room in winter it has but one knee, as shown in the figure; but I have since found that by drying it at a higher temperature a lower knee appears; in the wet state a "reverse twist" can be made out. The seed has a sharp oblique point, and a well-developed plume of hairs; the awn, like that of *Stipa*, *Avena*, and *Anemone*, is twisted into a right-handed screw. There are no feathery hairs on the non-twisted part of the awn; but it is covered throughout its entire length with minute reflexed barbs. I find it capable of burying itself on becoming wet; but whether it does so on becoming dry I am not sure.

HETEROPOGON CONTORTUS

has a doubly bent twisted awn, of which the vertical part is roughly 13 mm., the part between the knees 10 mm., and the non-twisted part 4 cm. in length. It twists in the same direction as *Stipa* &c.; and, when wetted, I have found it able to thrust itself into sand.

ANDROSCEPIA ARUNDINACEA.

The strongly bent and twisted awn is shown in fig. 3. I do not possess the complete fruit of this species, and could not make any trial of its burying-powers.

ANTHESTERIA CILIATA

somewhat resembles *Heteropogon melanocarpus*, with a bent and twisted awn, and a fine plume of hairs.

Lagurus ovatus has a bent and twisted hygroscopic awn. And I find the following kinds of grasses mentioned as having bent and twisted awns—*Aira*, *Arrhenatherum*, *Holcus* *, *Streblochæta nutans*, *Danthonia*, *Chetobromus Dregeanus*, *Macrochloa arenaria* †. I think it is probable that these have the power of burying themselves.

RANUNCULACEÆ.

ANEMONE MONTANA.

Fig. 6 gives the general appearance and proportions of the achene of this plant. The slight hairiness of the awn probably aids in the distribution of the seed. It is exceedingly remarkable that the general features of the above-mentioned burying-seeds, all members of the order of Grasses, should be repeated in a Ranunculaceous plant.

* 'British Flora,' Hooker.

† Max Wichura, translated in Taylor's Scientific Memoirs, May and Aug. 1853.

We have :—(1) seed more or less pointed, with a plume of hairs directed backwards (see fig. 8); (2) vertical awn twisting, when dried, into a right-handed screw; (3) horizontal, non-twisting portion rotating, when wet, in the direction of the hands of a watch, and coming into the same straight line with the lower part of the awn when the untwisting is complete; (4) cells of the twisting part capable of independent torsion.

With some difficulty I succeeded in observing the seed of *Anemone montana* bury itself almost completely during the process of becoming wet. I do not know whether it is capable of being buried deeper as it dries. Le Maout and Decaisne * figure the achene of *Anemone pulsatilla* as bent and twisted. Max Wichura † describes *Clematis azurea* as having the appendages to the carpels twisted.

GERANIACEÆ.

I merely mention this family to point out the general resemblance presented by the coccus and awn in some of its members to the burying-mechanisms already described. Fig. 5 (a dry *Pelargonium*-coccus) shows the flat, ribbon-like awn twisted into a right-handed screw, the knee, the horizontal non-twisted portion, the pointed fruit, and the plume of grappling-hairs.

It is undeniably true, as Hanstein points out, that the external surface contracts more strongly than the internal one in drying; but this does not account for the direction of torsion; I find that, as in the above-described awns, the cells are capable of independent torsion.

I have made no experiments on the burying-powers of the Geraniaceæ, as these have been already described by Hanstein, Roux, and Asa Gray.

When we find among organisms belonging to widely different groups a curious structural mechanism, repeating itself and performing in each case the same function, we conclude that this function is an important one in the economy of the plant. Thus, for instance, the importance of the distribution of seeds is pointed out by the existence of burs in widely different orders, such as the Compositæ (Burdock), Rosaceæ (*Geum*), and Rubiaceæ (*Galium aparine*)—of plumes to enable the seed to fly on the wind in many Compositæ, Apocynaceæ, Onagraceæ, &c.

Now in the burying seeds which we have been considering we have a similar case, a given function performed by essentially similar mechanism in plants belonging to widely different orders; and we accordingly conclude that the power of thrusting themselves into the ground is of special service to the seeds under consideration. Two theories suggest themselves.

(i.) My father has observed that certain seeds are almost incapable of germinating in the light, whereas they do so readily in the dark. This fact suggested that the power of self-burial has been developed to remedy the injury which the incapacity of the seeds to germinate in the light must cause to the species. I therefore made a comparative trial to determine this point. A number of *Stipa*-seeds were placed in a vessel half filled with

* English Translation, p. 175.

† Taylor's Scientific Memoirs, Aug. 1853, p. 302.

damp sand, and covered with a glass plate; half of the seeds were thrust into the sand*; the rest were allowed to remain on the surface. Contrary to my expectation, the seeds exposed to the light began to germinate first. I regret that I did not make a second trial with another lot of seeds; I think, however, that the above result is sufficient to overturn the theory in question, at least as far as *Stipa* is concerned †.

(ii.) The only other hypothesis which I have been able to form is, that by burying themselves in the ground the seeds are enabled to escape being eaten by birds. The fact that many of them are Gramineæ, and therefore likely to be sought after as food, favours this view ‡.

The developmental stages through which any structural mechanism has passed is always a most interesting question. Unfortunately I am as yet unable to enter into this question with respect to the burying seeds. We have seen that the mainspring of the mechanism is hygroscopic torsion; now many cells become twisted on drying, such as cotton-wool and bast fibres, the tubes of *Erineum* §, and curiously enough the beautifully striated cells which support the glands in *Byblis gigantea.*

Again, hygroscopic torsion depends on the spiral striation of the walls of the twisting cells. Now lamination or differentiation into more or less watery layers is probably a universal condition of the formation of cell-walls; so that the materials, as it were, for the development of hygroscopic torsion are certainly existent. The variability in the torsion of the cotton-wool cell shows that a want of unanimity in the direction of torsion would be one of the difficulties to be overcome in the process of development. Through what steps the hygroscopic sensitiveness has passed in development I am at a loss to say.

Finally, I venture to hope that my explanation of the torsion of awns may ultimately throw some light on other forms of torsion; and to this point I hope soon to direct my attention.

* For whatever reason the seed is buried, it would seem desirable that it should remain undisturbed. The joint by which the awn is attached to the seed seems adapted for this purpose; for after remaining a few days in damp soil the awn can be detached by the slightest touch. Roux points out the same thing in *Erodium.*

† G. Roux, *loc. cit.* states that *Erodium*-seeds germinate better when buried to the "normal" depth than when more or less deeply covered by soil. The details are not given in a manner to carry conviction.

‡ The seed of *Anemone montana* (one of the burying seeds) contains a large quantity of endosperm; the seed of this species is moreover, as far as I can make out, destitute of the acrid principle so common in the Ranunculaceæ, and which is found at least in some representatives of the neighbouring genus *Clematis.* Is it possible that the acrid principle may serve to prevent animals or birds eating the seeds of the Ranunculaceæ? as we know to be the case with the Bitter Almond ('Variation of Animals and Plants,' 2nd edit. vol. ii. p. 218). If so, the deficiency in the seed of *Anemone montana* of an acrid principle may be connected with the development of the burying-mechanism.

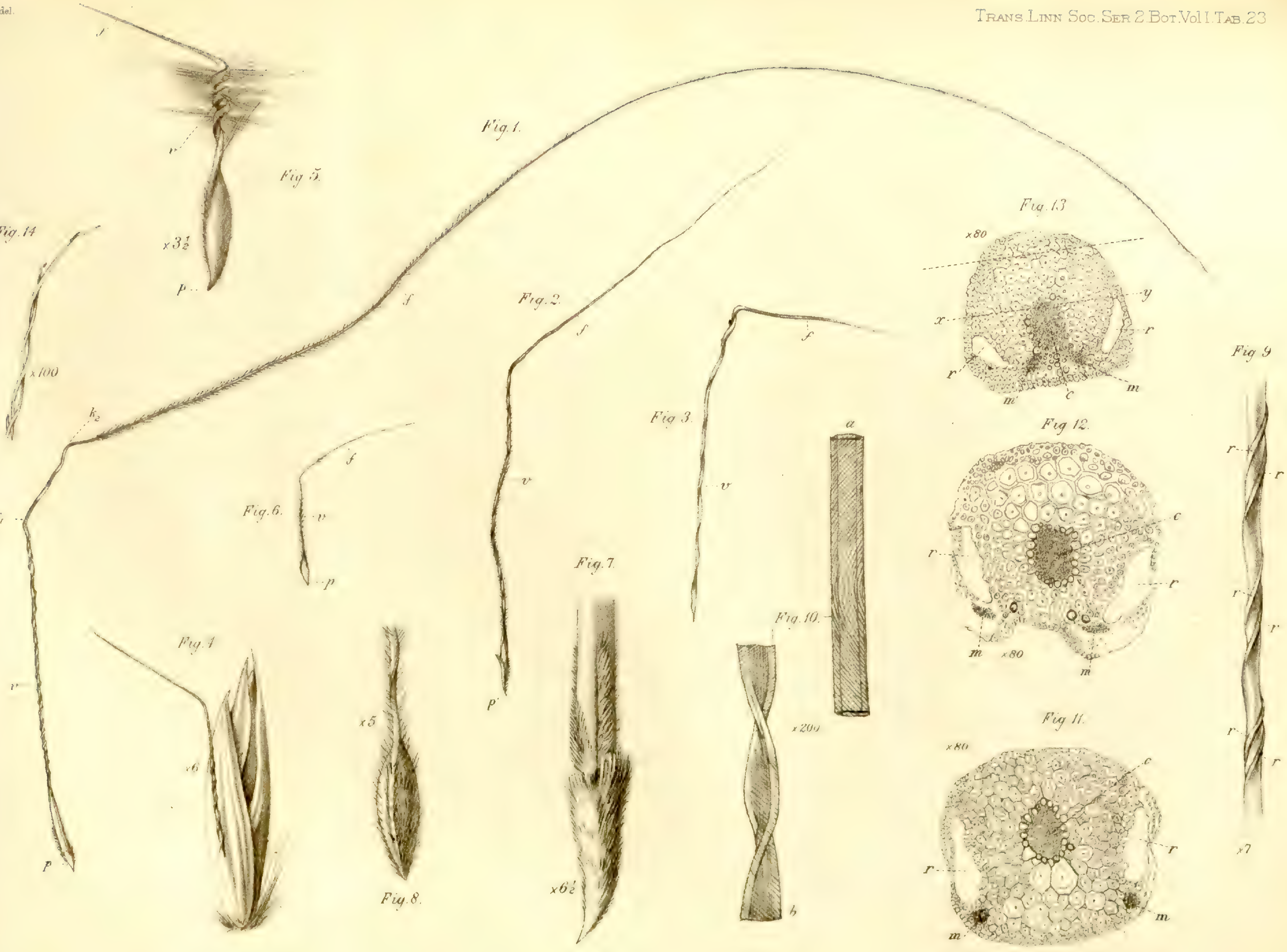
§ Sachs, 'Physiologie Végétale,' (translation: Geneva, 1868) p. 453, quoted from Nägeli and Cramer, 'Pflanzenphys. Untersuch.'

DESCRIPTION OF PLATE XXIII.

Fig. 1. Fruit and awn of *Stipa pennata* (natural size). *p,* the sharp point; *v,* the vertical twisted part of the awn; k_1 and k_2, the lower and upper knees; *f,* the non-twisted and more or less horizontal part of the awn.

2. Fruit and awn of *Heteropogon melanocarpus.* Letters corresponding to fig. 1.
3. Awn of *Androscepia arundinacea.* Letters as above.
4. Fruit and awn of *Avena elatior.* × 6.
5. Carpel and beak of *Pelargonium.* Letters as above. × 3½.
6. Achene and tail of *Anemone montana.* Letters as above: natural size.
7. Lower part of the fruit of *Stipa pennata.* × 6½.
8. Achene of *Anemone montana.* × 5 (about).
9. Upper part of *v* in fig. 1. × 7 (about). *r* and *r* are spirally running ribs, seen in section at *r* and *r* in figs. 11, 12, 13.
10. Cotton-wool cells. *a,* in dilute, *b,* in stronger sulphuric acid (from Nägeli). × 200.
11. Section of awn of *Stipa pennata* close to seed. *r* and *r* hollow spiral ribs (see fig. 9); *c,* central vascular bundle; *m* and *m* smaller masses of the same tissue; *c, m,* and *m* are non-hygroscopic. × 80.
12. Section of awn of *Stipa pennata* at k_1, fig. 1. Letters as in fig. 11. × 80.
13. Section of awn of *Stipa pennata* at k_2, fig. 1. Letters as in figs. 11 and 12. *x y,* line dividing awn into a more and a less hygroscopic part. On the other dotted line see text, p. 160. × 80.
14. External cells from the awn of *Stipa pennata,* isolated with nitric acid and chlorate of potash and then dried, to show the power of independent torsion residing in the cells of the awn. × about 100.

A. R. Darwin del.



C. Berjeau lith.

TORSION SEEDS, AWNS & SECTIONS OF GRASSES, &c.

M&N Hanhart imp.

THE

TRANSACTIONS

OF

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X. *On the African Species of the Genus* Coffea, *Linn.* *By* W. P. Hiern, *M.A., F.L.S.*

(Plate XXIV.)

Read April 20th, 1876.

As at present understood, the Linnean genus *Coffea* belongs to the Old World; and the numerous American species that have been previously referred to it, now find places in other genera. All the species most valuable for economic or commercial purposes are confined to Africa or are of African origin. Among the Indian species, at least one, *C. bengalensis*, Roxb., a native of Silhet, was in former times cultivated in Bengal for the growth of coffee; but being far inferior and not productive, it has been discarded on the introduction of the African plants.

Some of the Indian species originally described as members of this genus, belong to the following different genera:—*Psychotria*, Linn.; *Prismatomeris*, Thw. (*C. tetrandra*, Roxb.); and *Pavetta*, Linn.

The American species belong to *Appunia*, Hook. f. (*C. tenuiflora*, Benth.), *Coussarea*, Aubl., *Faramea*, Aubl., *Psychotria*, Linn., *Palicourea*, Aubl., and *Rudgea*, Salisb.

In Africa, besides the true species of *Coffea*, other berries are employed as coffee; but they are not of commercial importance: an example of this occurs in *Feretia apodanthera*, A. Rich. *Randia genipæflora*, DC., is called wild coffee by the people at Sierra Leone and in the island of Fernando Po, according to Barter's notes in the Kew Museum and Herbarium.

Of the species included in the present paper, in all fifteen, seven have been already published with descriptions, and the remaining eight are new or have not been previously described. One species, *C. arabica*, the original species of the genus, is believed to be indigenous in Abyssinia, also on the shores of the Victoria Nyanza and in the district of Golungo Alto in Angola, doubtfully also along the Mozambique coast, while the white-berried variety comes from Sierra Leone. Another species, *C. liberica*, belongs to Liberia, to Golungo Alto, and to Sierra Leone, though perhaps only cultivated in the latter place; two other species, *C. stenophylla* and *C. Afzelii*, are peculiar to Sierra Leone; one, *C. microcarpa*, to Senegambia; another, *C. rupestris*, to Abbeokuta; another, *C. brevipes*, to the Cameroons Mountains; another, *C. subcordata*, to Old Calabar; one, *C. jasminoides*, is common to Old Calabar, to the Niger region, and to Golungo Alto; another, *C. melanocarpa*, is peculiar to Golungo Alto; another, *C. hypoglauca*, to the district Pungo Andongo of Angola; two, *C. Zanguebariæ* and *C. racemosa*, to the Mozambique district; and, lastly, two, *C. mauritiana* and *C. macrocarpa*, to the Mascarene Islands of Bourbon and Mauritius. In other words, Upper Guinea contains 9 species, Nile Land 1, Lower Guinea 5, and Mozambique district with the Mascarene Islands 4 or 5.

The following key determines the classification of the species:—

Coffeæ *speciebus Africanis clavis adaptata.*

Glabræ, pleræque sempervirentes. Flores axillares.
 Calycis limbus brevissimus, annularis vel denticulatus.
  Antheræ omnino exsertæ.
   Bracteolæ obtusæ vel apiculatæ, calyce breviores. Flores glomerati, rarius solitarii.
    Corolla pentamera . . . . 1. ARABICA.
    Corolla hexamera vel heptamera vel octamera.
     Baccæ teretes. Folia subcoriacea.
      Flores glomerati. Folia breviter acuminata, 6–12-pollicaria . . . . 2. LIBERICA.
      Flores terni vel gemini vel solitarii. Folia caudato-acuminata, 2½–5-pollicaria . . . . 3. STENOPHYLLA.
     Baccæ nervis longitudinalibus angulatæ. Folia chartacea . . . . . 4. ZANGUEBARIÆ.
   Bracteolæ per paria lanceolatæ acutæ et deltoideo-apiculatæ, calyce longiores. Flores solitarii . . . . 5. BREVIPES.
  Antheræ semiinclusæ.
     Baccæ utrinque rotundatæ. Folia chartacea . . . . 6. MELANOCARPA.
     Baccæ utrinque acutæ. Folia coriacea.
      Folia 2–3-pollicaria, tenuiter coriacea. Corolla ¼-pollicaris . . . . 7. MAURITIANA.
      Folia 5–6-pollicaria, valde coriacea. Corolla ½-pollicaris . . . . . 8. MACROCARPA.
 Calycis limbus latus, lobis 5 rotundatis.
  Stipulæ lanceolatæ subulatæ. Bracteolæ parvæ, non foliaceæ.
     Baccæ subglobosæ, solitariæ vel subgeminæ. Folia 3–9 poll. longa, 1¼–3½ poll. lata . . . . 9. HYPOGLAUCA.
     Baccæ ellipsoideæ. Flores secus ramulos ad axillas fasciculati. Folia 2½ poll. longa, ⅝–⅞ poll. lata . . . . 10. MICROCARPA.
  Stipulæ e basi lata ovata apiculatæ. Bracteolæ foliaceæ . . . . 11. AFZELII.
Non omnino glabræ. Folia decidua. Flores terminales axillaresque vel laterales vel ramulos breves laterales terminantes.
 Folia ovalia, puberula vel glabra.
  Antheræ omnino exsertæ. Flores cum foliis coævi . . . . 12. SUBCORDATA.
  Antheræ fere inclusæ. Flores præcoces.
   Bracteolæ herbaceæ. Calycis limbus truncatus vel denticulatus. Corolla 5-loba . . . . 13. RUPESTRIS.
   Bracteolæ glumaceæ. Calycis limbus rotundate lobatus. Corolla sæpius 7–6-loba . . . . 14. JASMINOIDES.
 Folia ovato-lanceolata, tuberculis plurimis consita, scabra . . . . 15. RACEMOSA.

1. COFFEA ARABICA, Linn. Sp. Pl. p. 172 (1753).

C. laurifolia, Salisb. Prodr. Stirp. Hort. Chapel Allert. p. 62. n. 1 (1796), non Kunth.

Hab. Indigenous in Abyssinia, also on the slopes above the Victoria Nyanza (*Grant*), and in Angola (*Welwitsch*), and probably in some of the intervening countries; cultivated and often occurring spontaneously in Arabia and nearly all tropical and subtropical countries, including Madagascar and Natal; said to be wild along the Mozambique coast [see Klotzsch in Peters, Mossamb. p. 291 (1862)]. It, with its numerous cultivated varieties, is the source of most of the coffee of commerce.

Dr. Welwitsch found this species quite indigenous in primitive woods throughout nearly the whole district of Golungo Alto, as well as frequently cultivated; he describes it as a small tree, 10–15 feet high, with the trunk 9–12 inches in diameter at the base, and with horizontal or even nodding branches, which in old age become unilateral; it belongs to the 'Regio montoso-sylvatica' of Welwitsch, which ranges from 8° to 10° S. lat. and from 1000 to 2400 feet of altitude.

The commercial varieties of common coffee depend mainly upon their shape, size, and colour. The shape of the berries and of the seeds is said to depend on the particular portion of the plant on which they grow, those near the extremities being often obliquely rounded by the abortion of one of the seeds in the fruit; the size and succulence depend on the nature of the locality—those berries grown in a dry, hot, and rocky climate being smaller, less fleshy, and of superior flavour; and the colour depends on the degree of maturity attained by the fruit at the time of gathering. Some or all of these differences may also partly depend on the variety of the plant employed; but it is not known for certain whether the Mocha coffee is a distinct variety, or, as seems more probable, only due to a particular treatment and cultivation.

The following variety I have described, since it may prove to be a distinct species, characterized by white berries &c.; the flowers are unknown.

Var. *leucocarpa*, fruticosa glabra, foliis ellipticis vel ovali-oblongis breviter obtuse acuminatis basi cuneatis tenuiter coriaceis, venis lateralibus inconspicuis sub-6–7-jugis eglandulosis, stipulis e basi late ovata connata apiculatis petiolum brevem subæquantibus, floribus axillaribus subglomeratis, bracteolis ovatis quam pedicelli breves fructiferi brevioribus, baccis albis pisiformibus solitariis vel geminis, calycis limbo fructiferi obsoleto.

Hab. ad Sierra Leone, legit mense Junio anni 1841 *Th. Vogel!* no. 174.

Folia 3–6 poll. longa, 1–2 poll. lata. An species distincta?

2. Coffea liberica, sp. nova; Hort. Bull. Pl. XXIV.

C. fruticosa vel arborea glabra lucida sempervirens, ramis horizontaliter patentibus, foliis elliptico-obovatis oblongisve breviter acuminatis basi cuneatis vel obtuse angustatis subundatis tenuiter coriaceis $\frac{1}{2}$–1-pedalibus, nervis lateralibus utrinsecus 8–10 in alis puncto secretorio instructis, stipulis late ovatis apiculatis basi connatis quam petioli subbrevioribus, floribus axillaribus glomeratis subsessilibus pollicaribus, bracteolis connatis calyculatis depresso-deltoideis vel obtusis plerisque subtruncatis calyce brevioribus, calycis limbo annulari brevissimo, corollæ lobis 7–6 ovalibus obtusis tubum subæquantibus, antheris 7–6 omnino exsertis semipollicaribus, filamentis $\frac{1}{4}$-pollicaribus, stylo exserto bifido, baccis ellipsoideis $\frac{2}{3}$-pollicaribus vel ultra, seminibus semipollicaribus vel ultra.

C. arabica, Benth. in Hook. Niger Fl. p. 413 (1849), part., non Linn.

Hab. ad Sierra Leone, legerunt *Afzelius!* et *Daniell!* (cult.); in Monrovia, testibus *Th. Vogel* et *Daniell*; etiam in Angola (Golungo Alto et Cazengo) legit *Welwitsch!*

The source of the Liberian coffee, and probably also of the Cape-Coast coffee; it is said to be far superior to *C. arabica*, Linn., having larger berries, of a finer flavour, and being at the same time more robust and productive.

The name *Coffea liberica* was given by Mr. W. Bull, F.L.S., of Chelsea, in order to distinguish from the common coffee of commerce young plants which he obtained from seeds of Liberian coffee that had been sent from the west coast of Africa. He has since distributed the plant extensively under this name; but he had no idea whether it would prove to be a good species from a botanical point of view, nor did he intend the name to have any such sense or indication. However, as it turns out that the plant really constitutes a new species and requires a botanical name, I have thought it more convenient to adopt Mr. Bull's horticultural name, which has already received a wide distribution amongst plant-growers, rather than to take a manuscript name which Afzelius long ago gave to the same species in his herbarium, but which has never been published, and is entirely unknown to the public. Mr. Bull's name first appeared in his 'Retail List of new beautiful and rare Plants,' No. 97, page 4 (1874), and has been repeated in all the subsequent editions; he has given no botanical description.

The plant appears to have been first grown in this country in the year 1872 at Kew Gardens, from seeds contributed from Cape Coast, but only in very small quantity; in the following year living plants were imported from the west coast of Africa by Mr. Bull, who also in the same year obtained plants from seed; and at the same time numerous seedlings were raised at Kew. It is now produced on a large scale in this country for distribution to the various coffee-growing parts of the world.

3. Coffea stenophylla, G. Don, Gen. Syst. iii. p. 581, n. 4 (1834).

C. arabica, Benth. in Hook. Niger Fl. p. 413 (1849), part., non Linn.

Hab. Sierra Leone, *Afzelius !* and others.

In the Appendix to the Report of the Sierra-Leone Company, published in the year 1794, Afzelius states, on page 173, that "Coffee-trees are found of two distinct species, both nondescript; but whether of any use is not yet ascertained." This remark applies to this and the previous species. He subsequently discovered the economic value of at least this species.

According to G. Don, the seeds of this species are roasted and used as the common coffee, and are even considered superior to it. Afzelius, as has been explained, had recognized this as a distinct species; and among his manuscripts there remains a long description of it under an unpublished name of his own. It is the Highland coffee of Sierra Leone, according to Dr. Daniell.

4. Coffea Zanguebariæ, Lour. Fl. Cochinch. p. 145, n. 3 (1790).

Amazona africana, Spreng. Syst. Veg. ii. p. 126 (1825).

Hab. Zanzibar coast, *Loureiro*; Mozambique, *Forbes!*, *Loureiro* (cult.).

The seeds are said to be used in the same manner as those of *C. arabica*, Linn.

5. Coffea brevipes, Hiern, sp. nova.

C. fruticosa glabra nitida, ramulis gracilibus, foliis elliptico-obovatis acuminatis basi valde cuneatis firmiter chartaceis, venis lateralibus utrinsecus 6–8 gracilibus, stipulis e basi ovata valde vel rigide apiculatis petiolum brevem excedentibus, floribus axil-

laribus solitariis subsessilibus cum foliis coævis, bracteolis per paria lanceolato-acutis et deltoideo-apiculatis calycis limbum obsoletum excedentibus, corollæ lobis 5–6 ovalibus vel oblongis, antheris 5–6 omnino exsertis filamento bis longioribus, stylo exserto bifido, baccis lævibus ellipsoideis semipollicaribus solitariis.

Hab. in montibus Cameroons ad 2000–3000 ped. alt., legit mense Decembri anni 1862 *G. Mann !*, no. 2158.

Frutex 4–6-pedalis. Folia 4–8½ poll. longa, 1½–2¾ poll. lata. Flores dum expansi $\frac{1}{5}$–$\frac{1}{4}$ poll. longi.

6. Coffea melanocarpa, Welw. MS. in Herb.

C. fruticosa vel arborea glabra, ramulis erecto-patentibus, foliis ellipticis acuminatis basi cuneatis breviter petiolatis stipulos parvos obtusos excedentibus chartaceis, venis lateralibus utrinsecus 3–5 gracilibus, floribus pentameris sesquipollicaribus subsessilibus axillaribus subterminalibusque solitariis subgeminisve cum foliis coævis, calyce basi bracteolis omnino connatis calyculatis cincto, limbo annulari minimo, corollæ lobis ovalibus ½–¾-pollicaribus patentibus vel subreflexis, antheris majore parte inclusis subsessilibus stylo incluso, baccis demum aterrimis ellipsoideis vel subdidymis ⅓–½-pollicaribus.

Hab. in sylvis clarioribus circiter Sobati Bango et Bumba ad fluv. Delambra, in territorio Angolensi Golungo Alto non infrequens; mensibus Novembri et Decembri anni 1855 legit *Welwitsch !*

Frutex 4–6-pedalis, hinc inde arbuscula ejusdem altitudinis. Folia 1½–6 poll. longa, ½–2¼ poll. lata. Gemmæ florum exsudatione tenui vitrea fragili tectæ.

7. Coffea mauritiana, Lam. Encycl. Méth. i. p. 550, n. 2 (1783); Illustr. ii. p. 238. n. 3109, t. 160. f. 2 (1800).

C. arabica β, Willd. Spec. Pl. i. p. 974. n. 1, var. (1797), non Linn.

C sylvestris, Willd. in Roem. et Schult. Syst. Veg. v. p. 201. n. 28 (1819), fide DC. Prodr. iv. 499 (1830).

Hab. Bourbon, *Richard !*; Mauritius, *J. Grey !* In high mountainous forests.

Called *Café-marron* in Bourbon. It is mixed with other kinds of coffee; taken alone, it is said to have intoxicating properties.

8. Coffea macrocarpa, A. Rich. in Mém. Soc. Hist. Nat. Par. v. p. 168 (1834).

Hab. Mauritius, *Bouton !* In dense mountainous forests.

9. Coffea hypoglauca, Welw. MS. in Herb.

Arborea glabra, ramis patentibus, ramulis patulis, foliis ellipticis acuminatis basi plus minusve cuneatis tenuiter coriaceis nitentibus subtus glaucescentibus vel albescentibus, venis lateralibus utrinsecus 5–6 gracilibus, stipulis e basi lata lanceolato-subulatis acutissimis caducis petiolum excedentibus, baccis solitariis vel subgeminis axillaribus subsessilibus vel breviter pedicellatis subglobosis basi bracteolis ciliolatis imbricatis parvis rotundatis suffultis (immaturis viridibus pisi mole) apice calycis lobis 5 persistentibus imbricatis bracteolis conformibus coronatis.

Hab. in sylvaticis prope Catete in territorio Angolensi Pungo Andongo, cum fructibus mensibus Decembri anni 1856 usque ad Maium anni 1857 legit *Welwitsch!*

Arbuscula 8–15-pedalis et altior vel arbor parva 15–20-pedalis, ut videtur sempervirens, coma laxa, trunco recto gracili. Folia 3–9 poll. longa, $1\frac{1}{4}$–$3\frac{1}{2}$ poll. lata, petiolo $\frac{1}{5}$–$\frac{3}{5}$-pollicari; stipulis $\frac{1}{4}$–1-pollicaribus.

10. Coffea ? microcarpa, DC. Prodr. iv. p. 499, n. 4 (1830), non Ruiz et Pavon.

C. Perrottetii (?), Steud. ex Buek, Index DC., pars 1, præf. p. ix (1842).

Hab. Senegambia, *Leprieur & Perrottet.*

I have seen no specimen of this species.

11. Coffea Afzelii, Hiern, sp. nova.

C. glabra, ramulis patulis rubescentibus, foliis ellipticis vel ovato-ovalibus obtuse acuminatis basi cuneatis chartaceis, venis lateralibus utrinsecus 4–5 gracillimis, stipulis e basi ovata apiculatis petiolum brevem subæquantibus, floribus pentameris geminis axillaribus pedunculatis basi bracteolatis, pedunculis prope basim bracteis 4 parvis oppositis præditis, bracteolis foliaceis, calycis limbo 5-dentato, corollæ lobis 5 ovalibus obtusis, antheris 5 sessilibus faucibus nudis infra os insertis, stylo glabro.

Hab. ad Sierra Leone, legit *Afzelius!*

Folia $1\frac{1}{2}$–3 poll. longa, $\frac{5}{8}$–$1\frac{1}{4}$ poll. lata.

I have seen only a single specimen of this species, in Afzelius's herbarium, in very young flower.

12. Coffea subcordata, Hiern, sp. nova.

C. fruticosa, ramulis teretibus hispidulis patentibus gracilibus apice hispido-pubescentibus, foliis ovalibus obtuse acuminatis mucronulatis basi subcordatis firmiter chartaceis supra costa excepta glabrescentibus infra secus costam et nervos laterales 4–5-jugos hispidulis, stipulis e basi deltoidea caudatis setoso-apiculatis deciduis petiolum brevem æquantibus, floribus vel terminalibus glomeratis et axillaribus solitariis vel geminis et ramulos abbreviatos laterales terminantibus (4-) 5–6 (–7)-meris fragrantibus cum foliis coævis, bracteolis calycem excedentibus herbaceis quibusdam subfoliaceis, calycis limbo glabro 5-fido lobis rotundatis, corollæ niveæ tubo gracili lobis ovalibus obtusis, antheris omnino exsertis, stylo exserto glabro bifido, baccis rubris.

Hab. ad oppidum Old Calabar frequens; legit mense Martio anni 1863, cum floribus, *Rev. W. C. Thomson!* no. 35.

Folia usque ad $3\frac{1}{4}$ poll. longa et $1\frac{1}{3}$ poll. lata pervenientia. Flores $\frac{3}{4}$–$\frac{7}{8}$-pollicares, suaveolentes.

13. Coffea rupestris, Hiern, sp. nova.

C. fruticosa subglabra, ramis subteretibus cinereis patulis ramulis puberulis, foliis deciduis ovalibus utrinque angustatis glabris chartaceis, stipulis ovatis acutis vel apicu-

latis, floribus præcocibus pentameris candidis sessilibus ad ramulorum apices glomeratis fragrantibus, bracteolis herbaceis late ovatis apiculatis calycis limbum subtruncatum vel denticulatum brevem excedentibus, corollæ lobis ovalibus obtusis tubum æquantibus, antheris sessilibus majore parte inclusis, stylo bifido.

Hab. in rupibus ad oppidum Abbeokuta, legit *Barter!* no. 3343.

Frutex parvus; folia (juvenilia) pollicaria; flores pollicares.

14. Coffea jasminoides, Welw. MS. in Herb.

C. fruticosa plus minusve sarmentosa ramosissima, ramis patentibus decussatis puberulis vel glabratis, foliis ovalibus acuminatis rarius apice rotundatis sæpe mucronulatis basi rotundatis vel rarius subcuneatis oppositis vel rarius quasi quaternate verticellatis deciduis chartaceis nervis exceptis glabratis supra nitidis infra secus costam et 4–5-jugos nervos puberulis vel brevipubescentibus breviter petiolatis, stipulis e basi brevi lata subtruncata setaceo-apiculatis petiolum pubescentem subexcedentibus, floribus candidis extus sæpe roseo-sanguineis vel niveis fragrantibus sæpe subpendulis solitariis vel subgeminis lateralibus vel ramulos abbreviatos laterales terminantibus præcocibus subsessilibus basi bracteolatis, bracteolis glumaceis ovatis vel lanceolatis acutis imbricatis calycem excedentibus rarius quibusdam subfoliaceis, calycis urceolati limbo sæpius 8-fido lobis rotundatis rigidulo-membranaceis glabris, corolla 7–6- rarius 5-loba caduca, antheris sæpius 7–6 erectis subinclusis filamentis brevissimis, stylo bifido lobis patulis crassis lanceolato-spathulatis obtusis intus stigmatosis.

Hab. in sylvis et dumetis densis ad basim et declivia montium Serra do Alto Queta territorii Angolensis, Golungo Alto legit *Welwitsch!* no. 2572, Decembr. 1854 et Octobr. 1855 c. flor., etiam Novembr. 1855 et Junio 1856 c. fr.; in Nigritia ad Onitsha legit *Barter!* no. 1249 (suffrutex subscandens, baccis albis); etiam ad oppidum Old Calabar legit *Rev. W. C. Thomson!* no. 37, freq.

Frutex 2–5-pedalis; folia $1\frac{1}{2}$–3 poll. longa, $\frac{3}{8}$–$1\frac{1}{3}$ poll. lata. Flores pollicares vel sesquipollicares; bacca $\frac{1}{4}$–$\frac{1}{3}$ poll. diam.

15. Coffea racemosa, Lour. Fl. Cochinch. p. 145, n. 2 (1790), non Ruiz et Pavon (1799).

C. ramosa, Roem. et Schult. Syst. Veg. i. p. 198. n. 10 (1819).

C. mozambicana, DC. Prodr. iv. p. 500. n. 18 (1830).

Hab. Mozambique Island, *Loureiro.*

The seeds are said to be used for coffee. I have seen no specimen.

Excluded Species.

Coffea laurina, Poir. in Encycl. Méth. Suppl. ii. p. 14. n. 15 (1811), is *Craterispermum laurinum,* Benth. Sierra Leone.

Coffea cymosa, Willd. ex Roem. et Schult. Syst. Veg. v. p. 201. n. 27 (1819), is doubtfully referred to *Chasalia Fontanesii,* DC. Bourbon.

COFFEA CAPITATA, Sieb. Fl. Maurit. Exsicc. n. 335, is *Chasalia coffeoides,* DC. Mauritius.

COFFEA DIVARICATA, Tausch in Sieb. Fl. Maurit. Exsicc. ii. n. 271, is *Chasalia divaricata,* DC. Mauritius.

COFFEA HIRSUTUS, G. Don, Gen. Syst. Gard. & Bot. iii. p. 581. n. 5 (1834), is *Cremaspora africana,* Benth. Sierra Leone.

COFFEA KRAUSSIANA, Hochst. in Flora, 1842, p. 237, note, is *Kraussia floribunda,* Harv. Natal.

DESCRIPTION OF PLATE XXIV.

Plate of *Coffea liberica,* from a specimen in the British Museum, collected by Dr. Daniell in January 1856, at Sierra Leone, where it was cultivated : the flowers have been preserved in liquid. The principal figure shows a flowering branch (natural size), with a small lump of clear gummy secretion at the apex, with flower-beds in the next axils, with flowers (some fully expanded) in the next, and with very young fruits on the lowest axils that are included in the figure.

Fig. *a* shows a cluster of three calyces, also natural size, with the calyculate upper bracteoles covering the short pedicels, the middle calyx shown after the fall of its corolla, the right-hand one with a fully expanded corolla, and the left-hand one with a young unexpanded corolla.

Fig. *b* shows a vertical section, somewhat enlarged, of the ovary and epigynous disk by a central plane perpendicular to the septum ; the solitary ovules are seen to be attached near the middle.

Fig. *c* shows a pyrene as seen from the face, natural size.

Fig. *d* shows a lateral view of the same, also natural size.

Fig. *e* shows a dorsal view of a seed (natural size) cut away rather obliquely towards the base so as to expose the embryo with its inferior radicle.

I. Blair F.L.S. del. et lith.

COFFEA LIBERICA

Mintern Bros. imp.

XI. *On the Origin of Floral Æstivations. With Notes on the Structure of the Cruciferous Flower, on that of* Adoxa, *and on the Corolla of* Primula.

By the Rev. G. Henslow, *M.A., F.L.S., F.G.S.*

(Plate XXV.)

Read June 1st, 1876.

Introduction.

THE idea of endeavouring to trace out any laws that may exist amongst floral æstivations arose in my mind from observing the large number of *diagrams* given in Le Maout and Decaisne's 'Descriptive and Analytical Botany,' in which the æstivations of about 250 genera of Dicotyledons and of 50 of Monocotyledons are diagrammatically expressed. I therefore proceeded to draw up an enumeration of all the different kinds, and to ascertain what percentage each had amongst the genera, and what connexions there might be amongst those different kinds. I then examined a number of living flowers of several genera, but soon found my work had been to some extent inefficient as based upon very insufficient data *.

So far from each diagram given being the sole example or even always typical of a genus, I found it to be the commonest thing for a species to have a very considerable amount of variation, as will be seen at the close of this paper. As an example, the diagram of *Primula*, p. 529 (Engl. ed.) †, is not the only kind, as this genus can boast of at least eight varieties in the Primrose alone. Again, the diagram of the male flower of *Hydrocharis*, p. 754, does not correspond with the figure of the flower given there, in that the inner whorl of the figure is "tristichous," while it is represented as "convolute" in the diagram. Lastly, two diagrams of *Hermannia* are given on p. 284, as if it were an unusual occurrence for a flower to have its whorls running spirally in opposite directions, whereas it is an extremely common occurrence. Hence, if any one should be led to imagine these diagrams to be in all cases characteristic or the sole kinds of æstivation peculiar to each genus respectively, he will be much mistaken. It may be observed, however, that nothing is said respecting them whatever, as to whether they *do* represent typical forms or not. On the other hand, the æstivations of many genera are remarkably constant, such as the universally "convolute to the left" corolla of *Myosotis*; or again, the valvate calyx with contorted corolla of Mallow, though even here the "imbrication" may be either to the right or left; and when this is the case, it may become, as Robert Brown pointed out, a valuable diagnostic character.

* The draught of this paper was made on recovering from a long illness, when I had but few opportunities of testing the conclusions given from the study of the diagrams alone. I, however, give these conclusions, because the reader will be able to refer to the diagrams in that excellent work, and because the deductions made from a comparison of those diagrams is generally very similar to that derived from the examination of the variations in the flower-buds of living plants.

† The references to *pages* throughout this paper always refer to Le Maout and Decaisne's work.

Little attention, indeed, appears to have been paid to æstivations until that eminent botanist called attention to their importance *. Since then nearly all text-books describe the principal forms, but without tracing any or but slight connexions between them.

If we turn to our latest authorities, we find Le Maout and Decaisne, for example, devoting two pages (86, 87) to the subject in describing, as usual, the different kinds, and also attempting to explain the "papilionaceous" and "cochlear" by, as I believe, a wrong application of the "quincunx;" while in Sachs's 'Text-book of Botany,' "æstivation," "imbricate," "contorted," and "valvate," are words conspicuous by their absence from the index as well as from the text. Many diagrams occur in that work; but the subject of æstivation seems to have been totally ignored.

The laws of phyllotaxis have to some extent been adapted to the floral whorls, more especially and obviously to the quincuncial or $\frac{2}{5}$ plan. The very frequent occurrence of this latter amongst sepals and petals is of itself a sufficient indication that phyllotactical laws are in certain cases applicable—as also the fact that the outer whorls of flowers are in some cases composed of many parts and spirally arranged, especially when there is no manifest "break" between the whorls, as in *Calycanthus*, *Cactus*, &c. In these cases the $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, and even $\frac{8}{21}$ arrangements may be detected.

II. The Forms of Æstivation,

The following include those usually described, as well as one or two in addition.

1. *Distichous equitant, or the $\frac{1}{2}$ arrangement* in which one of the two opposite parts overlaps the edges of the other, as in *Papaver* (Tab. XXV. fig. 1).

The *half-equitant* is a modification of this, in which one edge of each part overlaps one of the edges of the other part respectively, as in the calyx of Poppy and the corolla of *Circæa* (Tab. XXV. fig. 2).

2. *Tristichous or the $\frac{1}{3}$ arrangement.* This is especially characteristic of Monocotyledons. It may be observed that it is identical with the "imbricate proper" when the whorl has only three parts, so that the first overlaps the second, and the latter overlaps the third, which last also underlies, with its opposite edge, the first (Tab. XXV. fig. 3).

3. *Pentastichous, quincuncial or $\frac{2}{5}$ arrangement*, in which the parts of the whorl correspond with those of one projected "cycle" of that plan (Tab. XXV. fig. 4).

4. *Half-imbricate.*—I apply this term to a large number of instances ranging from complete regularity to such extremely irregular forms as the corollas of the Violet, the Pea, and the Snapdragon. It is produced by a slight modification of the quincuncial—namely, by the edge of the second part being overlapped by instead of itself overlapping the fourth part (Tab. XXV. fig. 5).

5. *Imbricate proper*†, in which the parts of a whorl overlap each other in succession,

* A short summary of the history of the nomenclature of æstivations has lately appeared from the pen of Prof. A. Gray, in the American Journal of Sciences and Arts, vol. x. Nov. 1875, and is reprinted in the Journal of Botany, new series, vol. v. p. 53.

† I call this "imbricate proper," as the word "imbricate" is also used technically for an indefinite number of parts, as in the scales of *Calycanthus* &c., which overlap like tiles on a roof. Linnæus appears to have included all these forms (viz. 3, 4, 5, and 6) under this term (see Prof. Gray's paper *l. c.*).

so that one, the first, is entirely outside the adjacent parts, while the last is entirely within. This is deduced from the last by allowing the third member to slip one edge under the fifth, in addition to the second being under the fourth (Tab. XXV. fig. 6).

6. *Convolute and contorted.*—In these each part of the whorl overlaps one adjacent part by one of its edges, and is in turn overlapped by the other adjacent part (Tab. XXV. fig. 7). This is deduced from the preceding in a similar manner to that—namely, by passing an edge of the first part under that of the third.

Hence it will be seen that Nos. 3, 4, 5, and 6 are closely connected, and may be briefly expressed by saying the half-imbricate is formed from the quincuncial by having the 4th member over the 2nd, the imbricate proper from the half-imbricate, by having the 4th over the 2nd and the 5th over the 3rd, the convolute from the imbricate proper by having the 4th over the 2nd, the 5th over the 3rd, and the 3rd over the 1st *.

7. *Valvate.*—In this the edges of adjacent parts touch only, but do not overlap. The two main varieties, besides the simply valvate, where the edges just touch, are:—

Induplicative, where the edges are rolled inwards; *reduplicative,* where the edges are rolled outwards.

8. *Straight or open.*—In this the parts of the whorl are not sufficiently developed to meet even as in valvate, and therefore the æstivation may be said to be indeterminate.

III. The Degrees of Frequency of the various Kinds of Æstivation.

The following percentages are deduced from Le Maout and Decaisne, as stated above.

I. Dicotyledonous Angiosperms.

A. Imbricative.

1. Equitant Calyx	occurs about	4 p. c.
„ Corolla	„	12 „
2. Tristichous, Calyx, or Corolla . . .	„	11 „
3. Pentastichous, Calyx, with Cor. various	„	24 „
„ Corolla, with Calyx „	„	10 „
„ both Calyx and Corolla	„	14 „
4. Half-imbricate (excluding Papilionaceous and cochleate varieties) . .	„	15 „
5. Imbricate proper, Calyx, apparently very rare, as in *Cyclamen*, p. 529.		
Imbricate proper, Corolla	„	9 „
6. Convolute, Calyx, apparently rare.		
„ Corolla	„	16 „

* Prof. A. Gray's paper is chiefly directed to the settlement of the proper term for this kind; and he concludes that "convolute" is preferable to "contorted," as the latter does not differentiate corollas with a torsion, the petals of which have each a spiral axis, from those with no torsion, or whose axis is erect. A third term, "obvolute," would, he observes, claim priority as having been used by Linnæus; but it has not been in common usage. As the Professor concludes with the words, "I should hope rather than immediately expect that this use would become general," I have the satisfaction of fulfilling those expectations immediately; for although this paper was written before Prof. Gray's was published here, and I had adopted the word "contorted," I have altered it in every case to "convolute," in accordance with his wish.

B. Valvative.

7. Valvate (including varieties).			
Calyx valvate, with Corolla various .	occurs about	11	p. c.
Corolla valvate, with Calyx various .	,,	6	,,
8. Straight or open.			
Calyx open, with Corolla various .	,,	28	,,
Corolla open, with Calyx various .	,,	5	,,

II. Petaloid Monocotyledons.

1. Equitant is represented in 3 genera only besides Grasses.			
2. Tristichous, outer perianth whorl . .	,,	40	,,
,, inner perianth whorl . .	,,	60	,,
3. Pentastichous occurs in *Paris polyphylla*, p. 859.			
6. Convolute, represented in 4 genera only.			
7. Valvate	,,	20	,,
8. Open	,,	30	,,

IV. Remarks on the preceding Varieties of Æstivation.

1. *Equitant.*—The proportion of flowers which have equitant whorls, either entirely, when one member of the pair is embraced by both the edges of the opposite member, or half-equitant, in which each of the pair overlaps one edge of the other, occurs in corollas about 12 p. c. and in calyces about 4 p. c., as calculated from the diagrams of Le Maout and Decaisne. Probably this is not far from being correct.

With regard to the origin of this kind, I am inclined to think it is due to a reduction of parts from the tristichous or pentastichous arrangements, and in some cases may be a retention of a primitive condition. If one member of a tristichous whorl be suppressed, the other two will most probably become equitant, as flowers almost * invariably arrange their members either radially or bilaterally symmetrically. Such, I suspect, will account for this æstivation in poppies, for example, where the calyx is half-equitant and the corolla equitant (Tab. XXV. fig. 1). *Papaver* and its nearest allies of the tribe *Eupapavereæ* are usually binary or quaternary in their perianths, though whorls of threes are not wanting, and seem to point to their ancestral character, which is retained in *Romneyeæ*. Moreover *Papaver orientale* not unfrequently develops a third smaller sepal, which may or may not be accompanied by a trimerous corolla, which I take to be due to atavism.

If this theory be correct, the ancestors of poppies were trimerous; but by the arrest of one part in the calycine and one in each of the corolline whorls, these have become dimerous and equitant in æstivation.

* There are a few rare instances, due to insect agency, such as *Polygala chamæbuxus* and *Phaseolus*, which are, so to say, "distorted." I use the word *symmetrical* here in its popular, not botanical sense, as usually restricted, though Sachs applies it thus. The term *zygomorphic* has been used to express bilateral symmetry, and, if generally adopted, would avoid much confusion.

Or again, if we start with a quincuncial arrangement, the equitant condition is arrived at by suppressing either the first or fifth member. This, I think, has probably been the case with *Actæa* (p. 186) and *Adoxa* * (p. 474), as well as with the *Cruciferæ* †. *Circæa* (Tab. XXV. fig. 2), however, I am inclined to think owes its equitant æstivation either to an original dimerous symmetry derived from opposite leaves, or else it may be due to "symmetrical reduction" from a tetramerous type which prevails in the same order (*Onagraceæ*) to which it belongs.

If the equitant æstivation is presumably derived from a quincuncial whorl of five parts, by the arrest of one, the four remaining will probably be wholly equitant at first; but they may undergo further changes. If it be the result of a convolute æstivation, then the remaining pairs will more likely be half-equitant. Thus, if *Circæa* be derived from a tetramerous type with convolute petals, as occurs in *Epilobium*, by the arrest of two opposite parts, then it will be seen how each part of the remaining pair will overlap the other reciprocally, and the resulting æstivation will become half-equitant (Tab. XXV. fig. 2).

I would not, however, venture to lay very much stress on this supposed difference in the origin of half-equitant as compared with equitant whorls; for the overlapping of another by the edge of any part may be simply due to some slight advantage in growth quite irrespective of any cause arising from antecedent conditions—as, indeed, may be the case with the calyx of *Papaver*, which is half-equitant, though, as I presume, its dimerous character is derived from a tertiary type.

2. *Tristichous.*—This will be seen to be identical with an imbricate-proper æstivation when the whorl consists of three members only. It is very common in the perianth-leaves of Monocotyledons, occurring in the outer whorl about 40 p. c., and in the inner whorl about 60 p. c., as deduced from the diagrams of Le Maout and Decaisne. This possibly would require some modification; for I found the convolute æstivation also very common, as in about one third of the flowers of *Crocus* examined. This kind is represented by those authors as occurring in only four genera. In a pound of dates I found the percentage of the inner whorl of the perianth as tristichous to be 82, and as convolute 18. The outer whorl is gamophyllous, and reveals no succession of parts.

The origin of the prevailing ternary arrangement in Monocotyledons I take to be simply due to the fact that it does *not* arise out of opposite leaves, which latter, as I have shown elsewhere, gives rise chiefly to the pentastichous arrangement (Trans. Linn. Soc. sec. ser. vol. i. p. 37), so common in Dicotyledons; hence, as the usual phyllotactical requirements demand three leaves for every projected circle, and the floral requirements demand an alternation of position in the successive whorls, so by these two effects there issues the usual alternation of groups of threes.

In Dicotyledons there is a group of orders with a ternary arrangement prevailing amongst them (*Magnoliaceæ, Anonaceæ, Menispermaceæ, Berberidaceæ*), associated with a few genera or orders having a large number of imbricated parts in their floral whorls (*Dilleniaceæ, Calycanthaceæ, Nymphæaceæ*, &c.). When the whorls are in

* See Note B, p. 194, on the variations of the symmetry of the flowers of *Adoxa*.

† See Note A, p. 191, on the origin of the arrangement of the parts of a cruciferous flower.

threes in these orders, I believe it to arise as just stated, and as is more fully explained further on (Note C, p. 194) from phyllotactical considerations; that is, a prolonged spiral, instead of furnishing whorls corresponding to cycles, as in *Aconitum*, is simply broken up into decussating whorls of threes.

3. *Pentastichous or Quincuncial.*—This arrangement is one in which the parts of a whorl constitute one cycle of that leaf-order. Each successive member is at an angular distance of 144° from the next in order. It appears to be the commonest in Dicotyledons, obtaining either in one, two, or more whorls of a flower, and, from the diagrams of Le Maout and Decaisne, occurs about 50 p. c. This deduction is quite corroborated by observations on individual plants; for in the flowers *e. g.* of Primrose * (which shows eight if not more varieties of æstivation) the pentastichous was about 40 p. c. Similarly is it with *Viburnum tinus*.

What I have said upon the origin of alternate leaf-arrangements in my paper referred to above, fully accounts for this plan being the commonest among Dicotyledonous Angiosperms. Indeed I would venture to call it one of the fundamental plans, as giving rise to at least three others, if not more, such as the half-imbricate, imbricate proper, convolute, and possibly in part the equitant.

4. *Half-imbricate.*—I apply this term to a very common arrangement, which does not appear to have been at all recognized before, but which is nevertheless a very important type of æstivation. It is deduced from the pentastichous by the 2nd member of that kind having one of its edges passing under the 4th, and is not only the first step towards the imbricate proper, and thence to the convolute, but will also explain the æstivation of many irregular flowers, such as the "papilionaceous," that of the *Cæsalpineæ*, and the "cochlear" †, which, too, can be thus accounted for by a simpler method than is usually applied, and moreover a perfectly natural one, as it exists abundantly amongst floral whorls.

In the percentages deduced from the diagrams of Le Maout and Decaisne, that of this kind does not appear very high (16 p. c.). An examination of many flowers leads one to think it should be somewhat higher, as, *e. g.*, in *Laurustinus* it amounts to nearly 80 p. c., though in the Primrose it is certainly rare; similarly in *Ribes* it only amounts to about 10 p. c.

With regard to the papilionaceous corolla, if we consider the standard as No. 1, one of the keel-petals as No. 2 (of a quincunx), *which now passes under the wing, i. e.* No. 4, the wing on the opposite side of the median line will be No. 3, while the remaining keel-petal will be No. 5, coherent with No. 2.

* The diagram given by Le Maout and Decaisne of the Cowslip (miscalled Primrose), on p. 529, has both the calyx and corolla according to the imbricate-proper æstivation, and not pentastichous, which is much the most characteristic form. See Note D, p. 195.

Since this paper was sent to press, my attention has been called to Dr. A. W. Eichler's 'Blüthendiagramme,' in which he observes that this form is found both in regular and irregular flowers, and he gives a diagram of it for *Adoxa*, p. 270, and *Valeriana officinalis*, p. 275; but he retains the name "cochlear." This I purposely avoided, as it has only a specific and not generic value.

† In the translation of Le Maout and Decaisne the word "cochleate" is used instead of "cochlear," which is the correct term: the former is descriptive of a spiral shell, and would be applicable to the coiled legume of *Medicago*.

Le Maout and Decaisne endeavour to explain the structure differently, by conceiving No. 1 to be one of the wings, No. 2 the other wing, No. 3 a keel-petal, No. 4 the standard, and the remaining keel-petal No. 5. They thus derive it from the quincunx by removing the standard from being entirely *within* to a position entirely *without* the rest (fig. 466, p. 87). Similarly with regard to the æstivation of the *Cæsalpineæ* as represented by the diagrams of *Cassia* and *Cercis* (p. 367), though in these some confusion in the explanation is made by those authors; for in describing (on p. 87) these diagrams, they say,—" The standard retains its normal position [*i. e.* within the others], and the quincunx is properly formed." But in reference to the diagrams given in p. 367, this is clearly not the case. Both in that of *Cercis* and that of *Cassia*, if we take the outermost of the two anterior petals as No. 1, then No. 2 (whether the spiral be supposed to turn to the right, as in *Cassia*, or to the left, as in *Cercis*) is in neither case external also, as it ought to be for a quincuncial or pentastichous arrangement. If, however, we take, as I propose, the exterior anterior petal as No. 1, then the internal petal as No. 5, both the above kinds fall under this type, which I call half-imbricate.

It will be seen that No. 1 is not the same petal in both the papilionaceous corolla and that of these two genera of *Cæsalpineæ*. That this difference is of no relative importance will be shown hereafter. It may be remarked here, however, with regard to the standard not being identical with the fifth (internal) petal of *Cassia*, that the wings of the former lie over the keel, while in the latter genus it is just the reverse. This would seem to show that the papilionaceous resemblance is apparent only and not real.

The calyx in *Cassia* is represented as quincuncial, that of *Cercis* " open " and therefore indeterminate.

I recommend this interpretation as doing far less violence to the fundamental quincunx than that hitherto suggested; in other words, it is acquired by a simple alteration of position *of one edge only* of one petal. It may be observed, too, that it is obtained by regarding the parts of the spiral as running in the reverse direction to that according to the former method of regarding it.

This type of æstivation will also account for the so-called " cochlear," as of the Snapdragon (Tab. XXV. fig. 10, and Le M. & D. fig. 468, p. 87, in which the numbers there given should be exchanged respectively as follows, viz. 1, 5, 4, 3, 2 should be written instead of 1, 2, 3, 4, 5). Thus by retaining the innermost (anterior) petal as No. 5, and by merely shifting No. 2 partially under No. 4, we obtain the æstivation as illustrated by the diagram.

Another illustration of the half-imbricate in connexion with the quincuncial will be found in the diagrams of *Scrophularineæ*. The calyx of *Scrophularia* (p. 585) is strictly quincuncial: the exterior sepal, No. 1, is posterior *; but if this be compared first with the diagram of *Linaria* (p. 584), it will be seen that the 2nd sepal (the right anterior) now passes under the 4th (or the right), the spiral being right-handed †; and the æstivation of the calyx is therefore half-imbricate. It is similar to the calyx of *Paulownia* (p. 584); only this spiral is left-handed. But now comparing these with the calyx in the

* The diagram is wrongly placed. The left-hand exterior sepal is the posterior one in reality.

† On the distinction between right- and left-handed spirals, see below, note, p. 186.

diagram of Snap-dragon, p. 583, the 1st sepal is no longer the posterior one but the left anterior; the spiral is left-handed; and the posterior sepal is the 5th, and completely within the others. The corollas of all three genera have the same æstivation, and are constructed on this plan, which I call half-imbricate, having, at least most commonly, the 5th petal as the anterior one.

It is rare to find any other part than the 5th in the anterior position of the zygomorphic whorl, when its æstivation is half-imbricate. There is, however, one case figured by Le Maout and Decaisne, viz. the diagram of *Streptocarpus* (p. 598), in which the 4th petal is the anterior one. It is also thus in *Azalea* and *Rhododendron*, in which the 5th petal (always the single petal, which is entirely within the others) is the posterior one. Lastly, in *Pelargonium* alone all these arrangements may be found.

The above shows that no necessity can be seen for No. 1 of a whorl being always the same in position and therefore always homologous.

I have already remarked that this arrangement furnishes conditions varying from perfect regularity in the whorls to extremely irregular ones. A few references to the pages of Le Maout and Decaisne will illustrate this.

1. Corollas regular or very slightly irregular :—

Pittosporum, p. 248; Rue, p. 317; *Parnassia*, p. 403; Elder, 481.

2. Corollas partially or decidedly irregular :—

Moringa, p. 235; *Dictamnus*, p. 316; Horsechestnut, p. 357; *Cassia*, p. 367; *Rhododendron*, p. 516; Henbane, p. 578; *Vitex*, p. 615.

3. Very irregular corollas :—

Pansy, p. 241; *Lathyrus*, p. 369; Snapdragon, p. 87; *Lamium*, p. 620.

Irregular and zygomorphic flowers are sometimes produced without any departure from the quincunx; for it should be observed that both the quincuncial and the half-imbricate æstivations can be divided symmetrically into two similar halves (as represented in Tab. XXV. figs. 4 and 5) by median lines. Thus is it with *Polygala* (Tab. XXV. fig. 11), which somewhat resembles the papilionaceous; but the æstivation is simply quincuncial and without any modification. Similarly amongst gamopetalous corollas the diagrams given of *Alloplectus*, p. 597, as well as that of *Achimenes*, p. 596, and *Adhatoda*, p. 606, though possessing irregular bilateral flowers, have yet their petals arranged on the quincuncial plan.

Irregular flowers with a quincuncial æstivation would seem to be comparatively rare; and when it does occur the various parts are not always homologous. Thus in *Ramondia*, p. 600, *Alloplectus*, p. 597, and *Achimenes*, p. 596, it is in the 4th part, while in *Stilbe*, p. 613, it is in the 3rd part, and in *Myoporum*, p. 610, it is in the 1st part, which respectively occupy the anterior position.

5. *Imbricate proper.*—In this æstivation the parts of the whorl may be three in number, as in the tristichous; four, as in Holly, p. 339, and *Euonymus*, p. 342; or more commonly five or more. The parts overlap one another in succession, so that the first is wholly exterior, and the 'last' (which is really the third of the original quincunx from which it is derived) is entirely within the spiral. Le Maout and Decaisne number the parts in succession, fig. 463, p. 86; but this is not, nor can it possibly be correct, at least in accordance with phyllotactical principles; for if it were, we should have *five* parts

in a single projected coil or circle, which can only arise from the series $\frac{1}{4}$, $\frac{1}{5}$, $\frac{2}{9}$, $\frac{3}{14}$, &c. I observe Prof. Gray also notices the mistake of those authors, which occurs also in other text-books. If, however, we proceed from the last-mentioned æstivation, or the half-imbricate, in which the 2nd part lies under the 4th, and place the 3rd under the 5th, we at once obtain the present kind.

In the percentages deduced from the diagrams of Le Maout and Decaisne, it will be seen that this kind is much less common (only 9 p. c.) than the preceding; and what appears true for genera is also true for flowers of individual plants. Thus Laurustinus and Primrose give the percentage of imbricate proper as only 10.

6. *Convolute.*—As the last is derived from the half-imbricate, so this is obtained from the imbricate proper, by placing the 1st part under the 3rd of the quincunx; so that if we write the connexion of these three kinds successively, it will appear as follows:—starting with the quincunx, if we place the edge of No. 2 under No. 4, we obtain the half-imbricate; next, place the edge of No. 3 under No. 5, and we get the imbricate proper; and lastly, in addition to these, place the edge of No. 1 under No. 3, and the convolute is secured.

As long as the convoluted petals are erect and their median lines vertical there will be no torsion; but in some cases the apex appears as if it were artificially twisted, as in Mallow, Flax, &c. In these cases the word "contorted" can be applied either with or without "convolute" as well.

In turning to the percentages deduced from the diagrams of Le Maout and Decaisne, it appears that in corollas of different genera the number recorded gives the convolute variety a position of 16 p. c.; and in comparing this with the percentages of the same kind, deduced from flowers of the same species, as of the Primrose, it amounts to 15 p. c., or almost the same.

7. *Valvate.*—Of this kind of æstivation, with its two varieties induplicative and reduplicative, little need be said. They are comparatively rare both among sepals and petals. With regard to the origin of it, I believe, in possibly the majority of instances, it is due to a degradation from the imbricative kinds, using that term in a general sense. It is at least probable in all instances where the flower is presumably due to a spiral phyllotaxis. The diagram of *Geum*, p. 382, appears to afford an instance of a transition from the quincuncial to the induplicative in the petals, while the calyx has assumed a reduplicative form. I have reproduced this diagram in Tab. XXV. fig. 13.

In some cases where the flowers are dimerous or tetramerous, a symmetry which has probably risen from a similar opposition in the foliage-leaves *, it is also probable that no spiral arrangement has ever intervened. This may explain the fact of *Clematis* being nearly the sole genus (*Naravelia* is properly a subgenus only) of *Ranunculaceæ* which has opposite leaves and tetramerous flowers with a valvate calyx. Similar is it with the genera of *Oleaceæ*, as the Lilac, the sepals of *Epilobium*, of *Rhizophora*, &c. An illus-

* I hope to develop this idea on a future occasion. I would just call attention to the significant fact that of the genera of *Rosaceæ*, comprising 71 in all, as recorded in the 'Genera Plantarum' (Benth. and Hook.), three only have opposite leaves, and these three are alone characterized as having tetramerous flowers, viz. *Rhodotypus*, *Eucryphia*, *Coleogyne*.

tration of opposite foliage-leaves coalescing in venation in a valvate manner is seen in some species of shrubby *Veronicæ*.

Of course there are instances of a valvate calyx accompanied by an alternate arrangement in the foliage-leaves, such as *Malva*. These, as also all "open" kinds of æstivation, may be and probably are due to degradation, in consequence of which the parts only grow just sufficiently large to meet in the former case but not overlap, or else, as in the latter instances, to fall short of one another altogether, as in the *Umbelliferæ*.

V. Reversal of the Spiral.

A peculiar feature to be noticed is the frequent reversal of the direction in which the parts of successive whorls run, whether of the corolla in being different from the calyx, or the inner whorl of a monochlamydeous perianth from the outer. Of the 35 diagrams in Le Maout and Decaisne which have both calyx and corolla quincuncial, two have the calyx right-handed and the corolla left-handed. On the other hand, four have the calyx left-handed, while the petals form a right-handed spiral. All the rest have the calyx and corolla either right-handed or left-handed together *.

In examining several flowers of the same species, as in other matters, so in reversal, I found many single kinds of plants furnishing this phenomenon, as Crocus and *Malva sylvestris*, in which the right-handed and left-handed contortions were in equal proportions numerically.

VI. The numerical Order of the Parts of Whorls.

In examining the 34 instances of dicotyledonous Angiosperms, where both calyx and corolla are arranged on the quincuncial plan, the first petal of the corolla was found to be in 13 instances between the 1st and 3rd sepals; in 11 instances between the 1st and 4th sepals; and in 1 instance between the 5th and 3rd sepals. In all these cases the imaginary spiral line would be in the same direction, though not continuous from the 5th sepal to the 1st petal.

In 9 instances the spiral has to be *retraced* to discover the 1st petal. Of these latter in 3 instances the 1st petal lies between the 5th and the 2nd sepal, and in 6 instances

* With regard to the direction of the spiral, I always signify as *right-handed* the parts of a whorl the sections of which, as represented by a diagram, overlap on the right side, *as seen from the centre, i. e.* corresponding with the movement of the hands of a watch. I find this method more convenient for *diagrams* than the reverse, which is employed in the terms *sinistrorse* and *dextrorse* for spiral climbers. In that case it is more convenient to regard the spectator as being on the outside of the climber. Prof. A. Gray (*l. c.*) says:—"I note with satisfaction that Bentham and Hooker use these terms to signify from left to right or from right to left of a person supposed to stand outside of a closed bud, which is surely the natural position of the observer." This is without doubt perfectly true *for a bud*, but it is not *for a diagram*, which is a transverse section of a bud. In this case it is "natural" for the eye to rest on the centre. People invariably regard the hands of a watch as going from left to right; yet if instead of regarding yourself in the middle of the watch, you remember that you are outside of it, then the hands go from right to left when passing from 3 to 9 o'clock.

There appears to be some confusion in Le Maout and Decaisne's work; for they describe their diagrams, p. 80, of phyllotaxis as left-handed, though they are really right-handed if traced from the periphery to the centre; yet the descriptions of the two convolute corollas of *Hermannia*, p. 284, correspond to the method I have adopted; compare also the diagram of *Dianthus*, p. 256, which, again, is contrary to the latter, and is left-handed, though described in the text as right-handed.

between the 2nd and 4th; but in no instance amongst the diagrams given does it pass beyond two sepals. Lastly, in 7 instances, as stated above, the spiral of the corolla was completely reversed in direction from that of the calyx.

Similarly in turning to Monocotyledons we find, of the two whorls of the perianth, that some genera have both revolving the same way, others have one whorl the reverse of the other. Moreover the point where the second whorl begins in either case is as variable as in Dicotyledons. Thus, of those genera where both whorls revolve in the same direction, *Pinanga*, p. 812, and *Commelyna*, p. 568, commence the inner whorl with their 1st part between the 2nd and 3rd leaves of the outer whorl, both being right-handed spirals. In *Juncus*, p. 864, *Phormium*, p. 844, *Lapageria*, p. 856, and *Alisma*, p. 800—all being left-handed spirals—the 1st leaf of the inner whorl lies between the 1st and 2nd of the outer.

Again, in *Colchicum*, p. 850, *Fritillaria*, p. 843, while both whorls revolve to the right, the inner commences with its 1st leaf between the 3rd and the 1st of the outer. In *Butomus*, p. 798, Snowflake, p. 786, and *Toffieldia*, p. 851, the inner whorl commences diametrically opposite to the last leaf of the outer (that is, it lies between the 1st and 2nd leaf of that whorl), and moreover is in these three reversed in its spiral direction. In *Asparagus*, p. 859, the 1st leaf of the inner whorl lies between the 2nd and 3rd; while, lastly, in *Tradescantia*, p. 868, and the Pineapple, p. 766, it lies between the 1st and 3rd.

These statements clearly show that there is no single law causing a similarity of order in every case. On the contrary, the two whorls seem most capriciously arranged, the only common character being that in all flowers of two whorls to their perianth these should have their members alternating in position.

The preceding having been deduced from the diagrams of genera, I examined several species, and found that such variations as are here represented in different genera could be all illustrated by the flowers of a single species, as of the Snowdrop, Crocus, &c. I, however, retain the above paragraphs as referring to the diagrams, which will therefore furnish the reader with abundant illustrations.

VII. On the Causes which determine the various Kinds of Æstivation.

1. *Regular flowers.*—If the parts of a whorl are all on the same plane, it appears to be quite uncertain as to which member of the whorl shall be developed as the first or outermost, and that, if a calyx or corolla be both quincuncial, although theoretically their members are spirally arranged, yet practically No. 1 of the corolla may be any one of the five petals, and by no means necessarily as near to 144° as possible from the fifth sepal. This may be due to the fact that as the internodes are suppressed the nourishment is not only equally distributed over the circumference of the receptacle, but nearly or quite as equally in *time*, so that it is, so to say, a mere chance which part of a whorl gets the first start. Some slight differential impulse seems to occur with the first five kinds of æstivation; but with the convolute, valvate, and open no member can be called the first at all.

As in a single whorl the order of development of its parts is not always in accordance with the theoretically spiral arrangement, and still less is there any connexion between the

whorls by a continuous spiral growth, so also, in the order of development of the whorls themselves, it is by no means always true that they appear in succession acropetally.

Thus, as a consequence of a flower always terminating an axis, it is the fact that not infrequently there is subsequent intercalation of whorls exterior to some already formed. Thus in *Sileneæ* "the first whorl of stamens which appears is opposite the sepals, while the second is produced opposite the petals, and (according to M. Chatin, but my own observations scarcely corroborate the statement) *exterior* to the first-produced whorls"*. As far, however, as *Stellaria holostea* is concerned, the stamens opposite the petals seem to me to be intercalated *between* the first-formed stamens; so that the andrœcium forms one circle only. The petals, however, are decidedly later than both sets of stamens, the latter having attained considerable dimensions when the former consists of minute semicircular plates. This subsequent intercalation of whorls is perhaps due to what one may call "developmental energy" being stopped in its axial course, and, thus diverted, evincing itself by lateral or lower outgrowths. This also helps to explain the acrofugal order of expansion in *Adoxa* (see Note B, p. 194).

2. *Irregular flowers.*—There is, at least, a presumable probability, based upon what is known regarding the mutual adaptation of flowers to insects, that all irregular flowers have originally arisen by such adaptations, and that the varieties called "peloria" are reversions to the regularity of the primitive type †. Now, in order to become irregular, one obvious process is the greater development of one or more parts of a whorl, often at the expense of the others, which remain more or less dwarfed; so that it would be presumable *à priori* that irregularity would determine which part or parts should arise first from the receptacle. But this does not always appear to be the case, though at present I am not aware that any law has been discovered which regulates the order of growth. The fact that any adult part is larger than another part does not necessarily imply that it *started* first. Thus is it often with those anthers which appear first, and far outstrip the petals in size, as in *Stellaria*; yet the petals, when adult, often exceed the stamens immensely, as in the last-named genus and many others. A like remark may be made with reference to stipules of trees, as of the beech, which in the bud grow to four times the size of the leaf to which they belong, yet soon cease to grow, when the leaf ultimately exceeds them many hundred times.

M. Chatin (*l. c.*) also observes that the polystemonous andrœcia of *Mesembryanthemum, Opuntia, Cactus*, &c. are developed centrifugally; but the inner, older members become partially arrested, and the outer are the first to dehisce their anthers.

* "Some *Alsineæ*," that author observes, "with reduced flowers, give rise only to the whorl opposite the sepals. This is the rule in *Paronychiaceæ*, where sometimes the abortion of the stamens opposite to the petals is accompanied by the abortion of the petals themselves" (Bull. de la Soc. Bot. de France, C, 1874, p. 133). *A propos* of this fact, I would observe that these and other reduced flowers are mostly, if not all, self-fertilizing; and besides the degradation of the petals, as being no longer required for attracting insects, the number of stamens gets reduced, or more or less aborted; thus is it in *Senebiera didyma*, *Stellaria media*, *Viola canina*, and other species with cleistogamous flowers; sometimes the andrœcium is even barren, as in some early-developed individuals of *Capsella Bursa-pastoris*, *Glechoma hederacea*, &c.

† The order of "emergence" of the whorls of *Linaria vulgaris* is as follows—calyx, corolla (which is quite regular and spurless at first), stamens, and, lastly, the pistil.

In *Lamium album*, as illustrated by 'Sachs's Text Book,' p. 480, although 3 sepals appear before the other two, yet the adult calyx is scarcely irregular. On the other hand, the 5 petals appear together as equal-sized papillæ; the two posterior soon far outstrip the others, then arching over them protect the anthers even from a very young condition. The anterior petal in the adult stage is two-lobed, and might give rise to the impression that the lip was composed of two parts, whereas the history of its development reveals the fact that it is really single, while the "hood" is double. This is also corroborated by the fact that two vascular bundles run side by side between the two posterior and shorter stamens. In *Ajuga reptans* a converse process takes place, in that the posterior pair of petals soon become arrested, and the lip now grows rapidly, arches over, and protects the andrœcium just as the hood does in *Lamium*.

VIII. Varieties of Æstivation in the same Species of different Genera respectively.

Ranunculus bulbosus, or Bulbous Ranunculus.

Quincuncial	to the	right.	Occurred	about	22	p. c.
„	„ „	left	„	„	16	„
Half-imbricate	„	right	„	„	6	„
„	„ „	left	„	„	8	„
Imbricate proper	„	right	„	„	18	„
„	„ „	left	„	„	14	„
Convolute „	„	right	„	„	8	„
„	„ „	left	„	„	4	„

Anomalous:—Corollas having 6, 7, or 8 petals variously folded, but with a general tendency to be convolute; also a few with 5 petals, but abnormally imbricated.

Viburnum tinus, or Laurustinus. On a corymb, with 125 flower-buds.

Quincuncial	to the	right.	Occurred	about	23	p. c.
„	„ „	left	„	„	24	„
Half-imbricate	„	right	„	„	12	„
„	„ „	left	„	„	26	„
Imbricate proper	„	right	„	„	6	„
„	„ „	left	„	„	6	„

Anomalous:—Corollas with 6 petals, three instances; with 4 petals, one instance.

Primula vulgaris, or Primrose. Of 120 flower-buds examined.

Quincuncial	to the	right.	Occurred	about	22	p. c.
„	„ „	left	„	„	27	„
Half-imbricate	„	right	. . . . .		4	examples.
„	„ „	left	. . . . .		4	„
Imbricate proper	„	right	„	„	5	p. c.
„	„ „	left	„	„	6	„

Convolute to the right.	Occurred about	12 p. c.
„ „ „ left	„ „	17 „

Anomalous:—Two instances with corolla 4-merous; two with 2 exterior petals, and 3 convolute within; one with 1 exterior and 4 convolute, one with 6 sub-half-imbricate petals.

Ribes coccineum, or Crimson Currant.

Quincuncial to the right.	Occurred about	50 p. c.
„ „ „ left	„ „	33 „
Half-imbricate „ right	„ „	6 „
„ „ „ left	„ „	6 „
Imbricate proper „ right	„ „	6 „

Fuchsia coccinea.

Convolute to the left.	Occurred about	67 p. c.
Imbricate proper „	„ „	27 „

Anomalous:—1 petal exterior, 1 interior, and 2 opposite and equitant—of this, two examples; one example with six petals, 8 corrugated sepals, 6 stamens, and 4 carpels.

Cheiranthus Cheiri, or Wallflower. The corollas of this plant afford a great variety of æstivations. The chief kinds are as follow:—

Imbricate-proper to the right.	Occurs about	12 p. c.
„ „ „ left	„ „	14 „
Convolute „ „ right	„ „	14 „
„ „ „ left	„ „	6 „
Anomalous:—1 petal exterior with 3 convolute	„ „	12 „
Modifications of equitant	. . . .	37 „

Galanthus nivalis, or Snowdrop. Of 24 buds there were no less than 14 different ways of arrangement and order together.

In the following representations the outer whorl and numerical order are indicated by the upper figures, the inner whorl and the corresponding numerical order of its parts by the lower row of figures.

A. Examples of reversal of the spiral in the inner whorl as compared with the outer.

R. 1 2 3	Convolute to R.	L. 3 2 1	L. 3 2 1	Convolute to L.
L. 2 1 3	L. 3 2 1	R. 1 2 3	R. 2 3 1	R. 1 2 3

B. Examples of both whorls being right-handed:—

1 2 3	1 2 3	1 2 3
2 3 1	1 2 3	2 3 1

C. Examples of both whorls being left-handed:—

3 2 1	3 2 1	3 2 1
2 1 3	1 3 2	convolute.

D. Anomalous :—1 leaf external, the other 2 equitant.

CROCUS.

A. Examples of the reversal of spiral in the inner whorl as compared with the outer.

R. 1		2		3	R. 1		2		3	R. 1		2		3
L.	3		2	1	L. 3		2		1	L. 2		1		3

L. 3	2	1		L. 3	2	1	
R.	2	3	1	R.	1	2	3

B. Example of both whorls being right-handed,

1	2	3	
	2	3	1

C. Examples of both whorls being left-handed.

3	2	1		3	2	1	
	3	2	1		2	1	3

D. Both whorls convolute to the right.

E. Outer whorl imbricate proper, inner convolute. Sometimes both to the right, and sometimes both whorls to the left.

IX. Note A.—On the Symmetry of a Cruciferous Flower.

It has been customary hitherto to refer the structure of a cruciferous flower to a binary or quaternary type, though in different ways *. But, seeing that the leaves are so generally pentastichous, I would suggest a reference to an original quinary arrangement, with a subsequent symmetrical reduction by the arrest of the fifth member of each whorl; by which it will be seen that the relative positions of the organs as they occur in a cruciferous flower can readily, but of course theoretically, be accounted for. Thus, if the sepals be supposed to be arranged quincuncially, then the external position of the the anterior and posterior sepals will immediately follow, these being numbers 1 and 2 of quincunx. (Compare the figs. 13 and 16 of Tab. XXV.) Next, assuming the 1st of the five petals to lie between the 1st and 4th sepal (for the whorls must alternate), and the 1st of an outer whorl of five stamens to lie between the 1st and 4th petals, we shall have the 1st and 2nd retained as stamens (forming the two exterior lateral and lower ones), and the 3rd and 4th (opposite the anterior and posterior sepals) arrested or represented by glands.

The next whorl of stamens arising in a similar manner, it will be seen how the 1st and 4th will form, by approximation, one pair, the posterior, and the 2nd and 3rd the other pair. Lastly, the pistil is probably composed, as has been often suggested, of four carpels; but their union, according to my hypothesis, would be as follows. The two posterior carpels, numbers 1 and 4, coalesce to form the posterior half of the pistil, while the 2nd and 3rd, uniting in front, will form the anterior half. Thus two coherent

* A summary of the various theories may be found in Le Maout and Decaisne's 'Botany,' pp. 229, 230. See also "Note sur une monstruosité de la fleur du Violier (*Cheiranthus Cheiri*, L.)," par M. P. Duchartre, Ann. des Sc. Nat., 5me série, xiii. p. 315.

margins give rise to the posterior placentas as well as the stigma opposite to them (this latter being composed of two adjacent marginal and coherent stigmas). Similarly the two anterior margins of the 2nd and 3rd carpels will give rise to the anterior placentas, with *their* combined stigmas. The four lateral margins I conceive as cohering down the middle of the valves; but their placentas and ovules are usually arrested. The stigmas, however, of these lateral margins are normally present in *Parolinia*.

That the stigmas are marginal in the *Cruciferæ* was noticed by Robert Brown (Misc. Bot. Works, i. p. 558); so that the anomaly of their position over or opposite the placentas disappears. Fig. 17, Tab. XXV. (copied from Duchartre *l. c.*), shows these marginal placentas and stigmas developed on a carpellary stamen. The same stamen also shows (fig. 18) how the replum is formed, viz. by a prolongation of the outer side of the margins, the ovules being produced at a short distance within the edge. Lastly, fig. 19 (also from Duchartre) illustrates one of many combinations of carpellary stamens, in which the kind of arrest of the placentas and ovules I have spoken of, and which I conceive takes place along the median line of each valve, is seen at *a*. It may be observed, lastly, that the dehiscence of the siliqua, indicated at * in fig. 16, is, according to the above interpretation, strictly loculicidal, perhaps the commonest of all the methods, and is thus relieved of all the abnormal appearances.

There are some fruits of the *Cruciferæ* in which the venation is conspicuous, and would seem to corroborate this view. Thus in *Lunaria* and *Iberis*, for example, the transverse and branching veins are given off from the margins of the valve, and terminate by anastomosing on the median line. In other cases, where the venation is more obscure, a translucent line may be observed down the middle of the valve, marking, as I take it, the line of cohesion.

Besides *Parolinia*, mentioned above, *Tetrapoma* has four carpels; and *Brassica* as well as *Cheiranthus* not unfrequently develop two in addition to their normal number, under cultivation.

With reference to the supposed quinary origin of the flower, it may be observed that *Capparis* † has sometimes five petals; and *Megacarpæa*, if the figure given by Le Maout and Decaisne be true, may have exactly 10 stamens.

It may be asked on what grounds do I assume the right to suppress the fifth part of each cycle. The reply is, that such symmetrical reduction from a normal and typically higher symmetry is extremely common. Thus Rue (including *Haplophyllum*), *Adoxa*, *Hypopitys*, *Potentilla*, *Tormentilla*, &c. have habitually both 5-merous and 4-merous flowers; while the petals of *Lythrum Salicaria* range from 5 to 7 in number; similarly 4–8-merous flowers are found on Jessamine, Elder, &c.

If now we attempt to account for this reduction or increase, it is only conceivable by its being done by some similar or identical arrest or development respectively in each whorl. If, for instance, we draw alternate whorls of fives, and strike out *one* part, but *any* of each whorl, it will be seen how impossible it will be to form uniformly alternating whorls of fours out of the remaining parts. If, on the other hand, each whorl be

† I allude to *Capparis*, as whatever theory he advanced for *Cruciferæ* must apply to *Capparideæ* as well.

numbered quincuncially, No. 1 of each whorl being nearest that of the preceding, and on the same side of it, and then if we strike out all those, say, numbered 5, the remaining four parts in each whorl, on closing up the gaps, instantly form regularly alternating whorls of fours. Thus, then, I conceive the cruciferous flower to have arisen by a symmetrical reduction from fives to fours—first by the arrest of development of every fifth part of quincuncially arranged whorls, then by an additional arrest of a posterior and anterior stamen of the outer whorl, as well as a partial arrest of the carpels as described above.

A botanist who accepts the idea of a Crucifer being referable to a binary symmetry, is M. Victor Meschajeff *. He regards the two stamens constituting one of the taller pairs (as also of two adjacent petals) as reversions to a primitive type, and considers that the usual free condition of the stamens is a result of dédoublement.

I would take this opportunity of expressing my belief that this is a fundamentally erroneous view. It seems, too, to agree with Dr. Masters's expression of "inseparate" as a substitute for "cohesion." If cohesion, however, be objected to as implying a previous condition of freedom which never existed in petals normally joined, so "inseparate" would seem to imply that union was prior to freedom. There could be no reasonable objection, as far as I see, to the term "inseparate," provided no explanation of the condition is implied, but simply the fact that the parts are "not separate." Dr. Masters, however, qualifies the term by saying that the parts thus described as inseparate are *not separated*. The use of this participle at once introduces a new idea, and implies the existence of some tendency *to separate* what was before joined. Now this seems quite as objectionable as the term cohesion seems to that author ('Botany for Beginners,' p. 27) †.

But, according to the laws of evolution, integration, where it exists, is always subsequent to isolation or freedom. The rare cases of "dialysis," as of *Convolvulus* and *Campanula* with free petals, or of "solution," as of *Pyrus* and umbelliferous flowers with an inferior calyx, would be cases of reversion; while, in the *Cruciferæ*, freedom of parts, except in the gynæcium, is clearly a fundamental condition, as it has no affinity with any gamopetalous order: consequently the occasional cohesion of petals or stamens in any cruciferous flower *is not a reversion but a more advanced differentiated state*, and appears to be due simply to the close approximation of the parts thus occasionally joined.

If such a flower should ever have an apocarpous pistil, *that* would be a true instance of reversion; but no case of union could possibly be such.

For the above reasons I have always looked doubtfully on "chorisis" as a principle in flowers. Doubling or an increase of number of parts is common enough, as indeed

* Bull. de la Soc. Imp. des Nat. de Moscou, 1872, no. 2, quoted in Bull. de la Soc. Bot. de France, A, 1874, p. 16.

† Dr. Masters has been good enough to give me the following comment on these remarks:—" 'Inseparate' I apply to cases where separation of parts, though 'potential,' has not *yet* occurred, and wherein, if the course of development be arrested, it may never actually occur." But it is this very 'potentiality,' or tendency to separate parts, which I can only recognize as identical with atavism or reversion. Hence I think it ought not to be considered a principle of *development*, but rather a case of *retrogression*, and therefore exceptional.

occurs frequently in the *Cruciferæ* when two stamens arise from the same quadrangular or oval gland instead of a single lateral one; but this is not that one has given rise to two, but that in addition to the normal one another is present.

If, instead of regarding only the life-history of a plant *per se*, we regard it from an ancestral point of view, then "cohesion," as of the gamopetalæ, is the most correct term; for it implies that the parts *were* originally (that is, in their ancestry) free, but are *now*, in the existing descendants, coherent; whereas "inseparate" would imply that cohesion was an antecedent condition, and that there existed an ineffectual tendency to separate the parts of a whorl.

That a cruciferous flower has arisen through insect agency I have no doubt, and strongly suspect that the lateral single stamens are specially concerned in intercrossing. On the other hand, there are several of our common cruciferous plants which are self-fertilizing, such as *Capsella*, *Lepidium*, and *Senebiera*. In some of these I have often detected the pollen-tubes penetrating the stigma even in unopened buds, as in winter. These I take to be degraded conditions. In these, too, as far as can be judged from the relative heights of the stamens and stigmas, it would seem that the four taller stamens are chiefly, if not solely, concerned in self-pollination. In *Senebiera didyma* it may be observed that there are but two stamens; and they represent the taller pairs, one for each pair respectively. This reduction is a condition not infrequent in inconspicuous self-fertilizing flowers; for the number of stamens is often reduced, as mentioned above, in the flowers of several of the *Alsineæ* which do not require insect agency.

X. Note B.—On *Adoxa moschatellina*.

It may be interesting to some to have recorded the varieties which are found in the symmetry of the terminal as compared with the lateral blossoms. Of 71 heads of blossoms examined, all of which had the apical flower composed of whorls of fours,

60 had all four flowers 5-merous below,
3 had two 4-merous and two 5-merous below,
2 had three 5-merous and one 6-merous below,
3 had three 5-merous and one 4-merous,
1 had four 4-merous,
1 had two 6-merous and two 5-merous,
1 had the apical flower 5-merous, with three 6-merous and one 5-merous below.

This plant is also remarkable for the order of expansion in the different parts.

The terminal flower opens first; and its parts expand *all at once*. Of the lower flowers the two upper sepals of a flower open out first; then the two upper stamens are mature, and shed their pollen; next, the anthers below them dehisce in succession downwards, during which period the lower sepals begin to expand.

XI. Note C.—On the Origin of the Ternary and Quinary Symmetry of Flowers with indefinite and spirally arranged Members.

Calycanthaceæ.—Of the two genera comprising this order, both of which have opposite leaves, *Calycanthus* illustrates an abrupt change from opposite leaves to the $\frac{8}{21}$

arrangement in the bracts or bract-like sepals of the flower, but no differentiation occurs between the bracts, sepals, and petals respectively; whereas *Chimonanthus* (see fig. p. 191, in Le M. & D.) would seem to be a more highly differentiated type, in that not only is the calyx now distinguishable from the corolla, but five anterior stamens constitute a distinct whorl by themselves, and the indefinite barren ones of *Calycanthus* are here represented by five also.

How whorls or cycles of fives arise directly out of opposite parts has been fully described in my previous paper, quoted above, p. 181; so that I need not dwell upon it now.

Magnoliaceæ, *Berberidaceæ*, *Anonaceæ*, and *Menispermaceæ* are orders characterized by a ternary arrangement in their flowers, and by the whorls being usually double.

The origin of this might at first sight be thought to be the same as of the ternary arrangement, which is almost universal in petaloid Monocotyledons—namely, to have arisen from the tristichous phyllotaxis. But the fact that the perianth consists of 6 parts (=3+3) in the latter, and twice or more than double that number in some of the former, is significant, and would seem to imply a different origin, which I believe to be as follows:—For any phyllotactical arrangement corresponding to the fractions of the usual series, excepting $\frac{1}{2}$ or distichous, *every projected circle contains three leaves*; and on arresting the internodes of the flowers there always follows the tendency to alternation in position with the parts of the whorls immediately above and below. Hence the "threes" of each circle arrange themselves in a decussating manner. Thus in *Berberis vulgaris* we have 3 bracts, 6 (=3+3) sepals, 6 (=3+3) petals, 6 (=3+3) stamens, making in all 21 parts, corresponding to a cycle of the series $\frac{8}{21}$.

On the other hand, a flower of *Aconitum*, according to Braun, as quoted in Sachs's Text-Book, p. 530, is composed as follows: the sepals are pentastichous, or $\frac{2}{5}$; the corolla octastichous, or $\frac{3}{8}$; the stamens $\frac{8}{21}$, and the carpels 3.

Hence it would seem that there can be be at least four methods of disposing the floral members when numerous and spirally arranged, viz.:—

1. Spirally and with no breaks, then mostly $\frac{8}{21}$, e. g. *Magnolia*.
2. Broken up into fives, or $\frac{2}{5}$ arrangement . . „ *Chimonanthus*.
3. Broken up into threes, decussating . . . „ *Berberis*.
4. Broken up into whorls of 5, 8, 21, and 3 . . „ *Aconitum*.

XII. Note D.—On the Nature of the Corolla of *Primula*.

With regard to the theory of Pfeffer (see Sachs's Text-Book, p. 531), that in the *Primulaceæ* the corolla is an outgrowth of the andrœcium, I think there is more than one argument against it. Not only would the whole of the *Myrsineæ* have to be interpreted in a similar manner, but all analogy seems opposed to it. That the stamens are opposite the petals is true; but then *Samolus*, with its staminodia alternating with the petals, throws light upon this peculiarity; and if we examine the fibro-vascular bundles, it will be seen that ten pass into the tube of the corolla, five larger ones up the middle of each lobe, and *five smaller ones are intermediate*; each of the larger sends off a *small* bundle to the stamen adherent to the petal, respectively. The main portion

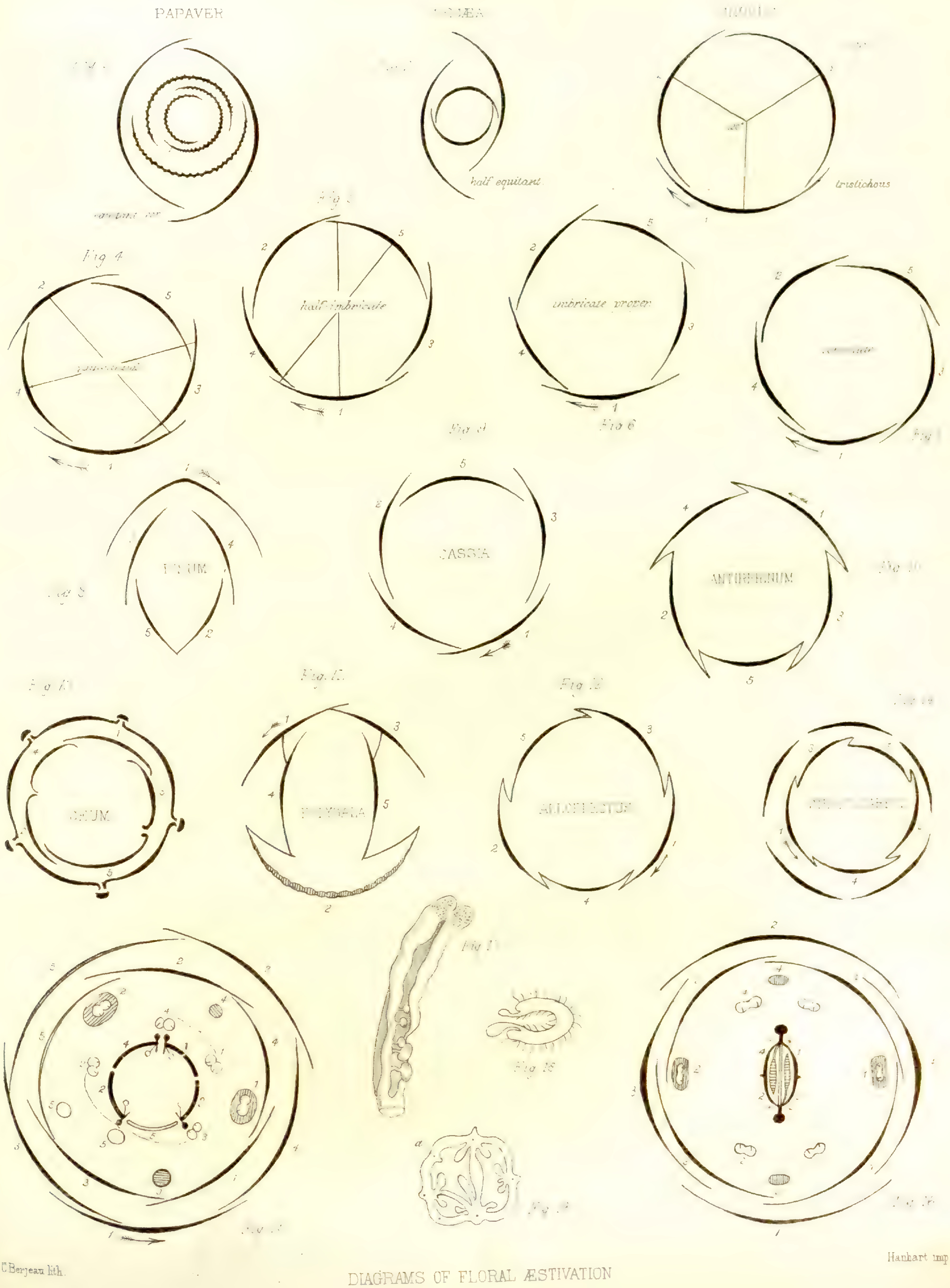
of the bundle continues its way to the notch at the summit of the lobe, and branches within the lobe. Now this is identically the same as in the calyx of *Prunus,* in which, as in the corolla of *Primula,* there are five median bundles, which do not bifurcate until they arrive at the lobes. The five bundles alternating with the petal-lobes of *Primula* or calycine lobes of *Prunus* bifurcate also on arriving at the notch between the lobes. They then send off dichotomously branching members up the adjacent edges of two lobes—that is, of two different members of the whorl.

The conclusion I would draw is this—that the calyx-tube of *Prunus* is homologous with the petioles, the lobes with the blades, and that the same holds good for the corolla of *Primula*; and I think we are justified in concluding that the corolla of the latter is a veritable foliaceous whorl.

Moreover the æstivation of the corolla of Primrose is strictly the same as in many other plants, and, if analogy is to be trusted, confirms this belief. Lastly, what is of chief importance is, that the theory being based, as no doubt is the only sound method, on development, is, however, as I interpret the facts, based on a misunderstanding of them—namely, that *because* the stamens appear first, and the lobes of the corolla *subsequently* (but they arise as soon as the anther is developed, *and are all connected by a horizontal band*), *therefore* the latter is an outgrowth of the andrœcium. But, as has been already observed, invariably acropetal or centripetal development of the whorls of flowers does not occur. That the corolla-lobes should develop *after* the stamens is by no means without parallel; for it occurs in many plants, as in the few following examples, in which the whorls are written in order of development:—

Ranunculus acris: Cal., St., Pi., Cor.
Stellaria holostea: Cal., St. opp. pet., St. opp. sep., Pi., Cor.
Lychnis dioica: same order, but without Pi.
Veronica chamædrys: Cal., St., Pi., Cor.
Cerastium glomeratum (self-fertilizing): Cal., Pi., St. opp. sep., St. opp. pet., Cor.
Arenaria trinervis (do.): same order.

Henslow del.



C. Berjeau lith.

Hanhart imp

DIAGRAMS OF FLORAL ÆSTIVATION

XII. *On some Points in the Histology of certain Species of Corallinaceæ. By* Major-General R. J. Nelson, *R.E., and* Prof. Duncan *(M.B. Lond.), F.R.S., Pres. Geol. Soc. Communicated by* Dr. Murie, *F.L.S.*

(Plates XXVI., XXVII.)

Read June 15th, 1876.

Contents.

I. Notice of the Histology of the Corallineæ by Quekett and Decaisne.

II. Notice of M. Rosanoff's Essay on the Histology of the Melobesiæ, so far as it concerns this communication.

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IV. The Histology of the Epiderm of the Frond of *Corallina officinalis* from temperate seas; notice of the Structure of the Cells of the Mass of the Frond.

V. The Filamentous Processes of the Melobesiæ of the Bermudas.

I. *Notice of the Histology of the Corallineæ by Quekett and Decaisne.*

Prof. John Quekett, who lectured at the Royal College of Surgeons, London, in 1850–1852, on the skeleton of invertebrate animals, published his course under the title 'Lectures on Histology,' in 1854. In the second volume that distinguished microscopist, whilst considering the calcareous skeleton of the Cœlenterata, very properly distinguished it from the remarkable hard substance of the Lithophytes, or the plants commonly known as Corallines. He gave a description of the common *Corallina officinalis* of the British coasts and also some important notices of the microscopical anatomy of the group. After noticing that when the Corallines are acted upon by dilute hydrochloric acid and the coating of lime is removed they become as flexible as any plant, he proceeded to explain that the terminal branches, which are of a round figure, exhibit the organs of fructification. The other species, *Corallina monile* and *Corallina opuntia*, he explained, are both largely coated with lime, but their joints are more evident than those of the common species. He then, after remarking upon the relation of the Nullipores to the Corallines, suggested that the comparison of the skeletons of the plants and of those of the true zoophytic corals is most interesting physiologically; for in both instances abundance of calcareous material has been separated from the sea-water by a vital process. He stated that on making a vertical section of *Corallina officinalis* "we shall find that on examination with the lowest powers it will exhibit two kinds of structures, both of which are essentially cellular—that on the exterior being formed of small cells of hexagonal figure, whilst on the interior they are more elongated and generally of a brownish colour: this is especially the case if the section should include a joint. In the fresh state the contents of the cells can be easily made out, and the central ones are not

unfrequently full of greenish granules like chlorophyll. The lime is not in the interior of the cells, but appears to be on the outside of the cell-walls, which are rendered opaque and thick in consequence." He examined this section with a power of 200 diameters, and delineated the results *. The drawing shows a very irregular patchwork of white spaces amidst a dark matrix; and the spaces represent the irregular cells without lime surrounded by the calcareous intercellular mass. Some long fibres are shown to be part of the articulation; and they are destitute of the mineral. He illustrated the general anatomy of the plant further by making a transverse section of a joint (*i. e.* a part between two articulations), and by dissolving it partly in dilute hydrochloric acid. The drawings † given by him exhibit the outer part of the section decalcified, and the inner as still retaining some carbonate of lime—so that externally there is a broad series of more or less hexagonal cells in radiating rows, whilst internally the cut extremities of the smaller cells are seen to be surrounded by opaque mineral matter. There is a remarkable addition to this delineation, which is not referred to in the context, in the form of a space included between two lines, which represents a homogeneous tissue on the surface of the lithophyte.

In noticing *Corallina incrassata*, he explained the very flexible nature of the articulations—and that by making a vertical section of one the elongated cells of it could be distinguished without any lime upon them, and having often a green colour. The delineation given of these sections shows long internal and hexagonal external cells, with a perfectly plain margin to the free surface of the plant.

Finally, in noticing the absence of any such articulation-cells in the Nullipores, he accounted for it by their slow growth in comparison with the more rapid increase of the Corallines, whose calcareous covering was therefore all the less.

It will be found on comparing Quekett's histological work with the essay by M. L. Decaisne ‡, that he was so far in advance of that author that it is hardly necessary to allude to it here. But there are some points of interest in M. Decaisne's paper, and some others which, if not explained, might appear to have forestalled the present communication.

The illustrations given by M. Decaisne are in plate 17 of the 2nd series of the Annales des Sciences Naturelles, 1842, vol. xvii. (the plate is marked "tom. 16"); and nearly all have been much improved upon by Quekett.

But the illustration of *Cymopolia barbata* is remarkable. The figure (12), of the natural size of the plant, resembles the appearance of the structures of many Corallines when magnified. Fig. 12 *a*, however, explains that the endings of the frond are dichotomous branchlets, which are covered with carbonate of lime. They thus differ from what will be explained further on. M. Decaisne noticed (see fig. 14 *a*) that a mucilage covered the *Corallina opuntia* (*Halymenia opuntia*), and that it formed a sort of cuticle which covered the surface of the articulations; but his diagram of the network of cells formed by the contact of those of the superficies is not in advance of that of Quekett.

* John Quekett, Lectures on Histology, 1854, vol. ii. p. 169 *et seq.*, fig. 85, p. 171.

† Quekett, *op. cit.* vol. ii. p. 171, fig. 85, fig. *d*, and fig. 86.

‡ L. Decaisne, Ann. des Sci. Nat. 2nd ser. vol. xvii. plate 17. Classification of Algæ.

II. *Notice of M. Rosanoff's Essay on the Histology of the* Melobesiæ, *so far as it concerns this communication.*

In 1866 Rosanoff contributed a paper to the Société des Sciences Naturelles de Cherbourg (2e sér. tome xii. pp. 1–112, plates i.–vii.) on the *Melobesiæ*; and, apparently ignorant of Quekett's work, he proved that anatomist to be correct, and advanced much beyond him. As we do not include the reproduction of those lithophytes in this communication, it will only be necessary to notice what M. Rosanoff states regarding the vegetative growth, so far as it relates to the Corallines. He considers that the carbonate of lime is in the intercellular spaces, or between the longitudinal walls of the cells, in the cell-walls, and in the position of the primordial utricle, and that it is arranged molecularly in the cellulose of the cell-wall. He does not find it in a crystalline or granular form, but as a thick and more or less perfect layer. He notices the variable amount of the carbonate of lime in different species. On examining the cell-walls of *Melobesiæ* he found them (before decalcifying) punctate or granular; and this structure resembled parallel lines crossing each other at almost right angles: hence he considers the lime to be intimately associated with the cell-wall structure. He observes that the reproductive parts are deficient in carbonate of lime; but he does not find that the rapidly growing portions of the plants are so deficient in it as might be expected; nevertheless he asserts that the parts deficient in the mineral are the free surfaces of the terminal cells.

M. Rosanoff shows that the cells of the plant are furnished with pores, one on each side of the cell-wall, perpendicular to the direction of growth, and that the pigment, starch, and protoplasm of the cells accumulate in their upper and outer parts. He explains that although each series of cells is radial, and grows by increase of the periphery, there is an increase laterally, and which relates to the shape of the frond. This takes place by what he calls copulation of cells, and is influenced by the pores in contiguous cell-walls. The copulation appears to be an absorption of the cell-walls of contiguous cells and a resultant irregular and large cell; and the pores permit of the nutrition of the deeper cells, so as to contribute an amount of common nourishment. He describes some large cells termed heterocysts.

M. Rosanoff explains that the *Melobesiæ* have a glutinous feel when touched on their surface; and in his diagrammatic sketches he places isolated cells on the free surface, each being the termination of a series leading deeply down *.

The Corallinaceæ have been the subject of our independent investigation; and most of the work of one of us (Major-General R. J. Nelson, R.E., then Lieut. Nelson, R.E.) was done in the Bermudas many years since. The drawings from life were then taken. Subsequently one of us working on the subject of the physiology of the Lithophytes, and unknown to the other, had examined the British and some other Corallines with care. Hence this joint memoir.

* Other writers (who do not offer any thing new) on the histology of the vegetative structures are Harvey (Brit. Marine Alg. pl. 13 C; Phys. Brit. pl. 222), Decaisne (Ann. des Sci. Nat. 2e sér. xvii. pl. 17. fig. 1, xviii. p. 119; The Micrographic Dictionary, 3rd edit.). See also Lamouroux, Bull. Soc. Phil. 1812 and 1816, p. 313; Philippi, in Wiegm. Arch. 1837; Kützing, Phyc. Gen. and Spec. Alg.

III. *On the Bermuda Corallinaceæ; their simple and compound filamentous epiderm; the structure of the external cellular tissue of the frond, its relation to the deposit of carbonate of lime, and the nature of the internal tissue.*

The high temperature of the sea at Bermuda, the absence of a cold season, and the abundance of carbonate of lime in and about its reefs, favour the growth of the Corallines and Nullipores. Under these physical conditions these plants assume an appearance of great beauty; for in the still pools amongst the reefs they may be seen in luxuriant profusion, each frond being enveloped in a delicate halo of filiform vegetation. Instead of the white or purplish smooth exterior which is so familiar to the investigator of northern forms and of dead specimens, that of the living Bermuda Corallines is hirsute, the hard calcareous analogue of the less-favoured species of Europe being beset with vigorous cell-growth. (Plate XXVI. figs. 2, 11, 14, 15; Plate XXVII. figs. 11, 13.)

In the warm sea of the Bermudas white Corallines are rare, and the prevailing colour is green, as in *Corallina tuna*, or full bright grass-green, as in *Corallina tridens*; sometimes the tint is bluish-green; and some Corallines are brownish green or even plum-coloured.

Their filamentous vegetation, or cell-growth, varies in amount and in its details according to the species; but in every instance it is continuous with the outer cells of the mass of the frond. The filaments are wonderfully varied in form * and structure: sometimes they are merely tubular and unicellular; sometimes they are very distinctly articulate; and in some species they branch. Their length varies also; for whilst in some vigorous forms they exceed in length the diameter of the joint of the frond to which they are attached, in others they are not quite as long, and in certain species they are not more than $\frac{1}{10}$ or $\frac{1}{20}$ of the length of the diameter of the plant. Many contain extremely minute spherules of chlorophyll or, rather, of colouring matter, whose minute bodies have such a significant appearance that they suggest some other physiological bearing than that of simple colouring matter. (Plate XXVI. figs, 3, 12, 16.)

These filaments, radiating on all sides and crowded together, resembling a confervoid growth on the frond, do not appear to be contractile; for they are passive under the movements of the numerous minute animals which move up and down and in and out amongst them. They possibly form the food of many minute animals, and are thus liable to be removed from their parent frond, a process which washing and drying will imitate. Nevertheless, if the algæ are carefully collected and placed on paper, traces of the filaments will last for a long time.

Very long filaments which are single, and have a direction rather oblique to the frond, are seen in *Corallina vermicula*. Filaments which are crowded and short, and which bifurcate, exist in *Corallina tridens*; and still shorter ones are observed with bifurcate and club-shaped ends in *Corallina tuna*.

Under a magnifying power of 100 diameters the outside of the dried frond of *Coral-*

* In order to see them to perfection the plant must never leave the water, and should be put into a glass vessel under the surface, and then removed in its temporary aquarium.

lina vermicula is covered with very regular and small polygonal spaces. Each space is separated by a narrow raised border from its neighbours; and the surface within the border is more or less depressed and has a central opening. The border and depressed surfaces are of carbonate of lime; and the first represents the junction of the outer cells of the cellular tissue of the frond at the outside, and each of the depressed surfaces consists of the carbonate of lime in the cell-wall of a collapsed superficial cell. Where there was no carbonate of lime in the central spot there was perfect cell-wall; and this disappears during desiccation. But the filament, long and slightly oblique, arose from this central spot, and therefore was much narrower than the whole cell from which it sprang, and was continuous. (Plate XXVI. fig. 17.)

In some parts of a specimen the minute dot-like space uncovered by carbonate of lime is not central, but close to the edge of the polygonal area; so that the filament did not arise invariably centrally, but often at one end; and it appears to be oblique. The polygonal spaces moreover differ in size, and some are more elongate than others; so that the distribution of the filamentous growth is not perfectly uniform. Towards the end of the frond the calcareous element does not predominate as it does elsewhere; and the green tint of the cells which are not affected by the mineral is very distinct.

On decalcifying specimens it is observed that the calcareous matter is granular, and that it is between the cells, in the cell-wall, and also within the cell to a certain extent. The inside of the frond is eminently cellular, and consists of series of long tubes and of compressed globes of carbonate of lime with faint central hollows placed longitudinally and radially. Beyond them is the outer coating of polygonal cells, which are intruded on by carbonate of lime—on their sides perfectly, but on their distal and proximal ends imperfectly, so as to leave some cell-wall in those situations. (Plate XXVI. figs. 15–17.)

Corallina tridens, when dry, has its surface covered with minute pits separated by ridges so as to assume a polygonal shape; and at the bottom of them, even in very old specimens, a dry slender filament may be seen projecting from a central part where there is no carbonate of lime. The spaces between the projecting ridges (or the pits) are produced by the collapse of the cell-contents during drying, and form part of the free ends of the external layer of cells. Each cell corresponding to a pit was infiltrated with carbonate of lime (except a minute central spot) during life. A very delicate cell-membrane covered the pits and ridges, and was continuous with the filaments also; this will be noticed further on as the analogue of the superficial epidermic layer of the British Corallines. Relics of this membrane are seen in dried specimens. It contained green colouring matter; and where it has been abraded the carbonate of lime of the underlying cells is glistening and white.

The filiform processes are very numerous in the living specimens, and form a complete down on the surface. They arise by a kind of neck-like constriction from the most external cells (those of the pits) of the frond, and are wider at their distal end, being otherwise cylindrical. They give origin at their remote end to two neck-like processes, which subdivide rapidly, and end in long club-shaped cells; so that the original filament produces four others. They are all tense with fluid and with marked distinct and numerous globular granules, more or less tinted green. (Plate XXVI. figs. 10–13.)

Corallina tuna, a bright green succulent Coralline, resembling *Corallina opuntia* in its habit, has its broad joints covered with a down of crowded and articulated filaments. The filaments are of several kinds. Some are simple long club-shaped cells; others are of the same shape at their base, but become compound by giving forth cells from the free end; and many, after having had these secondary cells developed, have others growing from them. All the cells are narrow at their origin, cylindrical, and largest at the end. (Plate XXVI. figs. 1–3.)

The surface of the joints of the frond is covered with a very minute areolation. Each minute area has its limiting ridges, and is regularly hexagonal, the ridge between the areas having a fine line on it. Each area is the top of a cell; and the ridge represents the intercellular space and the cell-walls also: it is calcareous. The calcareous deposit does not transgress over the front of the outside cells (those forming the areas) as it does in the Corallines already mentioned; so that almost all the area is semitransparent in dried specimens. But there is a little calcification of the outer wall nevertheless, except near the centre whence the filiform appendage of the cell arises; for the wall has a vitreous appearance. (Plate XXVI. figs. 4–6.)

The green colour of some of the dried joints is partly due to the preservation of an external superficial cell-membrane which covered all the calcareous cells, and which, as in the other Corallines, is a kind of lateral expansion of the base of the filiform processes, and is seen in *Corallina tridens* (see page 201). In the dried specimens the processes may be just traced, their proximal ends lying in the hollow of the area. The hollowing of the area depends upon collapse of the cell during desiccation.

This Coralline is only calcareous externally; for within there are ramose masses of great elongated simple cells, forming trunks near the articulation, and very fine branchlets near the underside of the outer expansion of the joints of the frond. Hence, on removing the film of calcareous cell-matter which forms the outside of the joint, these ramifications become visible. (Plate XXVI. figs. 1, 2, 9.)

On decalcifying a dry specimen, the paucity of the carbonate of lime in the frond becomes evident; for the ridges between the polygonal external cells are then seen to be mainly composed of true cell-wall: hence the mineral is mainly within that structure, and not much between the cells. There has been a deposition within the cells; for the relics of the cytioplasm are seen in some crowded up in a mass. The cells themselves look crumpled more or less, so as to give the appearance of raphides within them.

On the edge of a frond, in a decalcified specimen, the bases of the filiform processes could be seen, and a perfect process also. The cell-wall of the processes is well developed, and has glandular markings and slight prominences on it. (Plate XXVI. fig. 8.)

The ramose cellular structure within the joints is very remarkable; some of it consists of huge long cells constricted here and there, and of smaller cells with neck-shaped processes terminating in round bottle-shaped ends, which underlie the external layer of polygonal cells. (Plate XXVI. fig. 9.)

These species may be taken as the types which explain the external construction of the Corallines, and, to a certain extent, their internal configuration. They are all rapid

growers in comparison with the species of temperate seas; and they contain less carbonate of lime, joint for joint, than the well-known Corallines of our seas, although the whole plant may contain much more. Their cells are larger, and the whole plants present in their minute anatomy a great resemblance to some other little-known Bermudan Algæ, but which, whilst they resemble filamentous Rhodosperms, include carbonate of lime within their cellular tissue. The function of the filamentous processes and of the external delicate membrane can be readily interpreted. They are the only means by which absorption of the sea-water, and therefore of nutriment and carbonate of lime can take place. When once the intercellular spaces and the cell-walls have become infiltrated with granular carbonate of line, no further nutrition can proceed. At this time the deposit is free to collect within the cells; for the cytioplasm contains it. When large cells are cut into, they emit a rice-water-looking liquid, which deposits granular carbonate of lime.

The fronds increase, as it were, exogenously, by division of the external cells of the layer which gives origin to the filamentous processes. The superficial epidermal layer also develops a succession of external coatings to the frond; and therefore several of the above-mentioned layers are derived from it. The arrest of growth and the deposition of carbonate of lime have evidently some common relation. Hence in all probability the introduction of the mineral in the soluble form of the bicarbonate into the cytioplasm, cell-wall, and intercellular space progresses during the early life of the frond and whilst growth is proceeding. But as starch, cellulose, and carbonaceous granules accumulate, as growth becomes less vigorous a part of the carbonic acid of the bicarbonate is decomposed, part is retained, and part is lost, and the insoluble carbonate of lime is precipitated in the granular form.

The merging of one cell into another (the "copulation" of Rosanoff) has not been observed in the Bermuda Corallines; nor has any thing like a regular porosity of the cell-walls. But the presence of round spots where the cell-membrane is thin and more pervious to light is occasionally to be noticed in decalcified specimens.

In the cell-wall of the long internal cells there are markings which indicate a difference in the thickness of the wall; and on the surface of the frond the delicate external epidermal layer may be distinguished by curious puckerings and markings in its delicate tissue.

IV. *The Histology of the Epiderm of the Frond of* Corallina officinalis *from temperate seas; notice of the Structure of the Cells of the Mass of the Frond.*

The common British *Corallina officinalis* should be studied in the early spring time; for then its origin, from a greater or less expansion, may be examined, and there is then not much carbonate of lime in the frond. The expansion and short stumpy fronds are of a beautiful claret or port-wine-and-water colour, the articulations and the tops of the joints being greenish or colourless. Care should be taken to remove the stone to which the plant is attached without any washing movement; or the delicate external layer will be destroyed. The microscopic specimens, sections, &c. had better be mounted in glycerine; and if any acid be used, it should be weak hydrochloric

acid, the glycerine being used after washing as the medium. A polarizing apparatus is necessary. (Plate XXVII. figs. 1–9.)

Let the acid solution act slowly and for some time if the internal structures are to be examined; but if the delicate film of tissue which covers the frond is to be shown, a rapid development of gas-bubbles is rather an advantage; for it is tolerably certain to happen that some bubbles escape and blow out this tissue so that it can be examined.

Young specimens should be obtained; for experience and observation prove that minute Gasteropoda browse over the Corallines, and destroy much of the superficial cell-growth before it is much infiltrated with the carbonate of lime.

The surface of the frond of the Coralline, and also of the little basal expansion from which it rises, is covered with an exceedingly delicate cell-membrane (Plate XXVII. fig. 3). This is usually demonstrable after the action of dilute hydrochloric acid upon the frond; for the bubbles of gas escaping, separate it from the cellular mass of the plant which it covers. It resembles a beautiful pavement epithelium; its broad and shallow polygonal cells usually, but not always, touch by thin walls, and the whole is colourless. When seen in section in semi-decalcified specimens, the cells are observed to overlap those below, and, whilst covering the intercellular space, to be in organic connexion with the distal ends of the cells of the mass. No calcareous element enters into the composition of this superficial structure. Here and there an additional cell is seen on the free surface and covering one of those polygonal in shape; and near the joints, in some rare instances, the polygonal cell gives rise to a thread-like cell of about the length of $\frac{1}{4}$ of the breadth of the joint (Plate XXVII. fig. 2). In some forms from Port Natal, which greatly resemble *Corallina monile*, Ellis, the surface-membrane extends from joint to joint, covering the articulation and its elongate cells. This external tissue gives no evidence of containing carbonate of lime; but the cells have minute refractive dots in them. Finally, it is thickest at the free end of the joints of the frond, and there often exhibits rather tall cells, united together by a structureless protoplasm.

Beneath this superficial tissue are the terminal cells of the mass of the frond; and they are continuous with long rows more deeply seated. Each of these terminal cells is of a light green, and it succeeds a series which, gradually becoming darker with depth, assume a port-wine colour. The cell-wall is stout, a portion of it being perfectly transparent even in old specimens. This transparent portion forms either part or the whole of the distal end of the cell; and nearly all the rest is opaque. On decalcifying, it is found that the cell-wall, especially at the sides of the cell, and not at the ends, is incomplete here and there, as was noticed in the *Melobesiæ* by Rosanoff. There appears to be a possibility of connexion between the sides of contiguous cells. That this is a normal condition is probable from the small number of the pores; for did the incomplete condition depend on the removal of raphidic masses of carbonate of lime, there would be more of the pore-like markings, and their position would be irregular *.

* A careful examination proves that some markings on the longitudinal sides of the cell-walls of Corallines, already noticed, from Bermuda, are spots of excessively thin cell-wall. They are circular in outline, very few in number, and transmit light more readily than the rest of the tissue; they are, then, not absolute pores, but are pore-like, and are the seat of a very thin and diaphanous membrane.

The terminal cells contain viscid protoplasm, dark granules, and a nucleus. Their sides are, after decalcifying, evidently in contact; and when the process has been only partially carried out, a granular mass of carbonate of lime is seen to hide the side walls of contiguous cells, and to intrude on their internal space.

Having their side walls in contact after decalcifying, it is not probable that there can have been much of the calcareous element between the cells; there was some in the cell-walls, and also in the position of the primordial utricle. There is, however, frequently a small amount of calcareous deposition in the distal end of these outer green cells, but not enough to cover the whole surface. Nevertheless, when the whole frond of *Corallina officinalis* has matured, the whole of the distal end is covered, and thus the organic connexion between the superficial tissue and that beneath is destroyed. The proximal end of the outer green cells is in close contact with the upper wall of the cells beneath; and in the early days of the growth of the frond there is very little mineral deposition there: but later it occurs, so that finally these cells, and the others beneath them in the mass of the frond, are quite surrounded by opaque carbonate of lime, which is, moreover, amongst their cell-walls and within to a certain extent.

The superficial epithelial-looking layer of the British Corallines, and of some from Port Natal, is the homologue of the delicate homogeneous layer covering the more rapidly growing and less calcareous Corallines of the Bermudas; and the flat cells of the one are the analogues of the long slender filamentous processes of the others.

In some decalcified specimens from Bermuda the cell-wall of the cells supporting the processes, and of the deeper cells also, is very thick, and no pores are to be seen. After much, but not all, of the carbonate of lime has been removed, it is seen to be granular, to be included in the substance of the walls, between them, and in the cell. And when this last state occurs all the solid contents are crowded up in the middle. In a young frond of *Corallina officinalis* these outer cells are seen to be dotted on their sides with minute dark punctations after the action of acid.

Beneath the outermost green-coloured layer of cells of *Corallina officinalis* are others of the same colour or else of a light port-wine tint. They have dark granules, some of considerable size, within them; and in the instance of the port-wine-coloured cells the colouring matter is in solution as well as in the granules. The cells are cubical or oval in outline, some being elongate; they are in close contact with those in front and behind; but an intercellular space exists around the sides. That is to say, after decalcification, the slightest pressure will separate the sides of groups of cells; and it is in this position that the bulk of the calcareous element is deposited. This imperfect adhesion of the sides and the decided organic connexion between the ends of the cells in linear series, is more or less seen throughout the frond.

In young fronds the cells, especially when they are elongate, are crammed with cytioplasm, which aggregates in separate masses so as to exhibit a small moniliform series; and in the midst is a rather large nucleus and nucleolus. Sometimes there is to be observed a large circular dark line encircling a small zone of diaphanous wall, in the midst of which is a circular dark spot. All these cells are distinctly tinted. (Plate XXVII. fig. 7.)

Deeper still in the frond the linear series of cells, which are placed radially, are seen to branch; or, rather, two or three series unite deeply in one, and the size of the inner cells increases. All are very distinctly separate by their sides after the action of acid.

Amongst these deeply seated cells there are some which are long and fusiform: they run longitudinally through the joint, and deeply. They are observable in the middle joints, and not in the younger and terminal ones of the young frond. Each is crammed with two or more linear series of slightly flattened spheroids of colourless matter, very amyloid in appearance. And whilst in some a mass of dark port-wine-coloured cytioplasm may exist at one end, and a series of the amyloid bodies at the other, the majority of these cells, which sometimes bifurcate, are colourless; and in many no cell-wall can be distinguished, on account of the close packing of the contents. (Plate XXVII. fig. 9.)

These long cells, with their remarkable contents, are in relation with the filiform cellular processes of the articulations, and are often distinctly continuous with them, especially with the deeply seated ones, which run in a longitudinal direction throughout.

Each articulation consists primarily of a mass of long cells placed between the joints, and it has a deep and a superficial part.

The superficial part of the articulation consists of a thin layer of epithelium-looking cells, well seen by polarized light, and which is continuous with the common superficial layer of the frond; then follow long cells crowded closely together, and having a faint green tinge. Each cell has a thick wall, which is more transparent than the elongate protoplasmic contents; and usually the cell is long enough to extend from one joint to the other. It then is fixed on to a broader and shorter cell, whose direction is oblique and more or less radial; and it contains more or less colouring-matter, green or dark red. This obliquity of the outer layer of the articular cells close to the joint produces decomposition of the polarizing ray, and the phenomena of alternating light and darkness and of complementary colours.

The deeper cells of the articulation are elongate, like the others; they are very long, numerous and crowded, and have thick cell-walls and a linear mass of cytioplasm. They pass straight on in either joint, and merge into long cells without colouring-matter, or else into a series of the fusiform cells noticed above.

It appears, from examining very young specimens, that the outer part of the articulation is developed from the outer layers of the joints by elongation of their cells, and that the deeper layers are produced from the elongate and longitudiual series of the frond.

As growth proceeds, the fine tissue on the articulation is lost, the long cells increase in breadth and length and in the thickness of their walls, their contents becoming semi-solid.

Occasional dissepiments occur in the long cells of the articulation, and also short processes of the cell-wall; but often they are not visible. Polarized light, however, is a great assistant in the investigation.

A small amount of carbonate of lime is found amongst the superficial layer of cells; but it does not appear to exist in and amongst the deep and long cells of the articulation.

In older fronds, and in some Corallines from Port Natal, the superficial epidermic layer is very distinct; and beneath it the cells of the first layer of the mass of the frond

are convex outwards, having very thick walls; but their walls are not usually perfect in outline. They have a double contour-line; and this ceases over a greater or less part of the position where cell-wall might be expected to be found. This absence is due principally to collapse of the cells after decalcification, and, to a certain extent, to the presence of a lateral pore. (Plate XXVII. fig. 5.)

The absorption of the adjoining cell-walls of cells and the conjugation noticed by Rosanoff have not been observed in the sense in which the terms are employed by that author. In the mass of the frond a large cell may be seen to have incomplete dissepiments at its distal end; but these are the beginnings of the sprouting of two perfect cells from it in order to multiply the series. This occurs largely all over the joints, and even in the outer layer, the increase being lateral there and in the direction of the periphery.

V. *The filamentous Processes of the* Melobesiæ *of the Bermudas.*

Like the Corallines, the *Melobesiæ* live and flourish luxuriantly in the Bermudas; and it is interesting to announce that, like their articulated allies, they present external appearances of which no conception has been had by the observers in temperate climates*.

The Nullipores chosen as the types upon which to explain the appearance of luxuriant external filamentation, and which form the subject for our plates, are two in number:—First, a very ramose species, with rather expanded ends to short and widely diverging branchlets. (Plate XXVII. figs. 10, 11.)

The branchlets are solid, very concentric in their layers, and are minutely punctate.

The fine hair-like growth from their external surface is wonderfully developed; and the extremely delicate and greatly crowded filaments are as long as the branch is broad. They radiate in all directions.

The second form arises from a stem; and its branches, irregular in shape, inosculate, and ascend close together, so as to form a conical mass. (Plate XXVII. figs. 12, 13.)

The crowded filamentous growth is placed around the branches, and extends outwardly from the frond to about one half of the diameter of the branch.

It is evident that these filamentous growths are the analogues of those of the Corallines, and that all have the same important function in the nutrition of the plants.

* Nullipores are closely allied to the Corallines both in structure and in their office in nature. Any one who has studied the blocks and masses of coral reef which the Sapper and Miner has blown up when they impede navigation, —or *on* which the naturalist has crawled, or *round* which he has been wading or swimming by the hour together—will readily admit the good service done, not only by *Nullipora*, but by many and many another firm and respectable *Vegetable Coral* as a cement, cooperatively with the bond, at times, supplied by Gorgonidæ &c. in the formation of so-called Coral Reefs, in a way quite distinct from the comparatively homogeneous proceedings in the structure of Tubicola reefs.—R. J. N.

DESCRIPTION OF THE PLATES.

Plate XXVI.

Fig. 1. *Corallina tuna*: natural size.

Fig. 2. A joint magnified, and showing the hirsute surface and the long branching internal cells.

Fig. 3. Filiform processes or hairs from the outside of *Corallina tuna*, magnified.

Fig. 4. A portion of the surface of an old and dry specimen of *Corallina tuna*, magnified, showing the spots in the cells where there is no carbonate of lime.

Fig. 5. An external cell of the same Coralline, more highly magnified. The dark spot is the position of the former attachment of a hair or filament.

Fig. 6. An external cell collapsed and the relics of a dried filament, magnified.

Fig. 7. External cells of the frond of *Corallina tuna* decalcified, and magnified.

Fig. 8. Part of the edge of a decalcified frond of *Corallina tuna*, showing the hairs and glandular markings on them, magnified.

Fig. 9. The large simple and branching cells of the interior of the frond which terminate at the base of external cells, magnified.

Fig. 10. A portion of the dried fronds of *Corallina tridens*.

Fig. 11. A portion of a fresh frond, magnified, showing the superficial hirsute covering of filamentous growth.

Fig. 12. A group of hairs arising from the external cells of the frond of the same Coralline, magnified, from a fresh specimen.

Fig. 13. The appearance of the external layer of cells, with vestiges of dried filaments and of parts without carbonate of lime, magnified, from a dry specimen.

Fig. 14. A group of *Corallina vermicula*, after Nelson and from the living specimen.

Fig. 15. A fresh frond, magnified, from the life, showing the oblique and long hairs, of *Corallina vermicula*.

Fig. 16. A group of external cells and their long hairs, from a fresh specimen, magnified.

Fig. 17. External cells of *Corallina vermicula* with broken cell-wall, indicating rupture of the filaments. From a dry specimen, magnified.

Figs. 2, 3, 11, 12, 14, 15, 16, are from drawings from nature by Major-General Nelson, R.E.; figs. 1 and 10 are from specimens collected by Major-General Nelson.

Figs. 4, 5, 6, 7, 8, 9, 13, 17, are drawn from specimens prepared by Prof. Duncan, and under his direction.

Plate XXVII.

Fig. 1. A portion of a young frond of *Corallina officinalis*, magnified.

Fig. 2. A portion of the same frond close to the edge of an articulation, showing scattered and long simple hairs, magnified.

Fig. 3. A portion of the surface of a frond decalcified. The lower arched portion has become separated from the upper and darker part by accident; it indicates the superficial layer of cells. Magnified.

Fig. 4. The superficial cell-layer, from above, magnified.

Fig. 5. The appearance presented by the outer cells of the frond beneath the layer above (figs. 3 and 4) in decalcified specimens. The thickness of the cell-wall and its incomplete condition are shown. Magnified.

T. Berjeau lith.

CORALLINES & STRUCTURAL DETAILS.

Hanhart imp.

Nelson & Duncan, del

C.Berjeau lith.

CORALLINES AND NULLIPORES

Hanhart imp

Fig. 6. Internal cells of a frond decalcified, showing pore-like markings, magnified.

Fig. 7. Internal cells, crowded with dark-red granules and spheres of the same tint, ending in elongate cells, forming part of the articulation, magnified.

Fig. 8. One of the broad cells, magnified, showing a collection of cytioplasm.

Fig. 9. A mass of refractive granules from one of the cells in a young frond, magnified.

Fig. 10. A portion of a ramose nullipore (*Melobesia*) from Bermuda, natural size.

Fig. 11. A litttle branch of the mass, magnified, showing the great development of the external filamentous growth.

Fig. 12. An undescribed species of *Melobesia*.

Fig. 13. A portion of the mass covered with the filamentous growth from the external cells, magnified.

Figs. 1—9 are drawn from specimens prepared by Prof. Duncan.

Figs. 10-13, are from drawings by Major-General Nelson.

XIII. *On the Minute Structure and Mode of Growth of* Ballia callitricha, *Ag.* (*sensu latiori*). *By* W. Archer, *F.R.S.*, *M.R.I.A.* *Communicated by* W. T. Thiselton Dyer, *M.A.*, *F.L.S.*

(Plates XXVIII. & XXIX.)

Read June 15th, 1876.

SOME small fragments only of this alga (mixed with some of the freshwater algæ enumerated by me in the Society's 'Journal,' No. 87) were at first met with in gatherings made by Mr. Moseley, of H.M.S. 'Challenger,' in Kerguelen's Land. They were much macerated and wholly deprived of colour, very few of the cells indicating the presence of contents, and the cellular structure being rendered hyaline. I submitted such a specimen to my friend Prof. E. Perceval Wright, who, aided by one at same time given to me by my friend Mr. Gilbert Sanders, identified it as a form of *Ballia callitricha*; and on comparing it with perfect examples in the herbarium of Trinity College, Dublin, the diagnosis was sustained. However, on a closer search of Mr. Moseley's collection, I afterwards found that it contained, in addition to the isolated and broken-up fragments, some complete and characteristic examples of our *Ballia*; so that the identification was complete. I was much pleased to find these latter in the gathering, as they afforded, of course, much more suitable subjects for study—though even the first small shreds which I had noticed not only presented examples of a minute and apparently characteristic structure within the cells, which thus seems to possess some histological interest, but they likewise showed some interesting points relating to the outward configuration and mode of growth of this alga, all of which, so far as I can see, seem to have hitherto remained unnoticed.

The fact that a Rhodosperm should have occurred in a collection made from fresh water and containing characteristic freshwater forms, possibly does not in reality possess that amount of interest which at first glance might seem to appertain to it. It is true that the algæ of marine type which strictly belong to the fresh waters are very few, and they are but of small dimensions and humble habit, and not at all striking. Such are, for instance, *Chantransia*, *Bangia*, *Hildenbrandtia*. In *Ballia* we have a type, indeed, more elevated, more pronounced, than any of these, an elegantly configurated and compoundly branched form; but I should be much inclined to suppose our specimen was a mere marine *waif* (possibly blown in by the wind); or it may have been taken from a site to which the sea had only occasional access (and cast in by the surf)*. The more

* I am further indebted to Prof. Perceval Wright for drawing my attention, however, to a record by Dr. Montagne (addressed to the Academy of Sciences, May 13, 1850) of the fact that M. Lemprieure had collected in the running waters of Guiana three species of *Bostrychia*, one *Gymnogongrus*, and two of *Ballia*. These were found either in rivulets of the mountains of Mahuri ("80 kilo." from Cayenne) or in the watercourse of the creek Gravier, in the Kan mountains ("40 kilo." from the sea, and at an elevation of 100–150 metres). The waters presented no trace of salt; and their elevation precluded all thought of any flow back of the tide bearing germs of these plants. Of the *Ballia* examples, which were minute forms, one (*Ballia pygmæa*, Mont.) grew attached to a *Batrachospermum*, the other (*B. lemprieurii*, Kütz.) to stones.

important interest of the specimen, then, attaches rather to its being the first in which the specialities alluded to have been noticed.

The whole plant is of a rigid and tough character; nor, when it is viewed under the microscope, is this surprising, when the cell-wall is seen to be so very thick, composed as it is of several laminæ. Now the peculiar and interesting internal character alluded to is, that in the boundary walls of the cells or "joints" there occur always two opposite terminal, and in some of them, in addition, two lateral, pairs of more or less wide (seemingly circular) pits—a character, indeed, found in other Rhodophyceæ, long ago pointed out by Nägeli*; but what would appear to be novel (so far as I know, indeed, it is unprecedented in other departments of plants †) is, that each of these pits is covered by a comparatively large *lid* or *stopper*, not organically united or persistently adherent; at least very small accidental force seems to suffice to dislocate and remove them.

In Mr. Moseley's example, in every joint of the plant, whether of the main stems or rachises or of the ultimate ramifications (except the apical joints), there occurs a "pit," with its "stopper," at *each end of each joint*—that is, at least two such in each cell (see the figures *passim*); in the apical joints there occurs but one (at the base). In many cells of the rachises and of certain lateral cells (presently to be noticed) there occur besides *yet other pairs of smaller pits and stoppers*, as will be hereafter explained. Why these pits

* 'Die neuern Algensysteme.'

† Something optically resembling the "stoppers" above referred to presents itself during the conjugated state of *Mesocarpus nummuloides*. It is well known that in *Mesocarpus* the spore is formed within the transverse canal (formed in the characteristic manner between the two conjugating cells) by the passage thereinto of their chlorophyll-plates enclosing the granular and oily contents, which become massed in the middle, whereupon ensues the division of the now H-shaped cell into three by formation of two septa, one to each side of the transverse canal, the middle cell becoming the spore, the two limbs (the parent cells) cut off seemingly as effete, though still containing colourless slightly granular plasma. As maturity advances, and when the spore presents its three consecutive walls, the median brownish and coarsely scrobiculate, it is seen to be ultimately freely suspended in the surrounding medium, but still posed between the somewhat geniculately bent pair of parent cells. Now, in addition to the original septum cutting off the primary parent cells, the outer apertures of the disjunct transverse canal, now separated at both sides from the free spore, is seen to be *covered by a plano-convex "lid,"* much thinned off at the periphery, of a semipellucid, somewhat "pearly," aspect, and sufficiently strongly calling to mind the appearance of the "stoppers" in *Ballia* above referred to. This lid in *Mesocarpus* may be seemingly composed of a condensed kind of mucus. What its purport, I could not hazard a conjecture; but it certainly appears puzzling that so much pains, as it were, should be expended on hermetically "sealing up" these apertures in a structure whose function would appear to be over, containing, indeed, some as yet living (?) plasma, though robbed of its chlorophyll, but nevertheless seemingly destined to be but cast off as of no further moment.

The "lids" here adverted to are often, indeed, sufficiently obvious; yet I do not know that they have been noticed in algal works. Their possessing a certain amount of *resemblance* to the stoppers in *Ballia* renders an allusion to them here possibly not altogether out of place, though in the case of *Ballia* the stoppers are within the cell-cavity, but external to the "primordial utricle," whilst in *Mesocarpus* the corresponding structures are (at least ultimately) external to the cell—that is, washed by the surrounding water: still their deposition must presumably have been carried on, at least begun, whilst the spore-cell remained organically united or in intimate apposition with the parent cells at each side.

Whether, as suggested by Prof. Dyer, the "hemispherical depositions of cellulose" sometimes met with on the inner side of the pollen-cell wall, *e.g.* in *Cucurbita pepo* (Sachs's 'Text Book,' p. 32, woodcut *v*), are to be considered analogous to the structure ("stoppers") here adverted to is probably questionable, but is doubtless deserving of further investigation.

are formed at all, or what special function they subserve, is not apparent; but the marvel is, that no sooner are they in existence than the openings seem to be thereupon again methodically plugged up.

The terminal pits, with their corresponding stoppers belonging to the same cell, are as far as possible distant from each other, at the remote basal and upper ends of the cavity, whilst the pits appertaining to neighbouring cells (as is usual where pits occur in higher plants) are placed directly opposite to one another. Each pit is somewhat narrower at its inner end than at the mouth; hence the two pits, viewed together, present an outline like that of a "pulley" in edge-view (Pl. XXVIII. figs. 11, 18). In the long and large cells of the main stems the pits are the largest, whilst they diminish gradually in size in the joints of the upper portions of the principal stems, or of the secondary or tertiary rachises, *pari passu* with their degree of tapering or attenuation (that is to say, with the decreasing size of the cells), until in the joints of the ultimate branches or pinnæ they become at last very minute, like mere granules or dots, but still quite perceptible (Pl. XXVIII. figs. 2 & 14).

So far as can be learned by a close examination in joints which have not become injured, the primary membranes of the joint-cells seem to close up the bottoms of these adjacent pits; at least, a line can readily enough be discerned occupying that position (figs. 11, 16, 18). But frequently this appears, on examination with a high power, to have become obliterated; not only so, but instances were noticeable where the contracted protoplasmic contents of one of the joints (now quite colourless from the action of the spirit) had become from some cause thrust through the foramen (thus proving that these are real openings, not mere markings or even alterations of density or otherwise), the mass of contents (thus one half in one cell, the other in the other) roughly forming a figure-of-8 shape, owing to the constriction caused by the narrowness of the aperture.

Corresponding to this gradual diminution in the size of the pits of the stems and secondary branches onwards to the ultimate pinnules, there is not only a gradual diminution in the size of the "stoppers," as mentioned, but also a gradual modification of their figure. In those appertaining to the cells of the principal stems they are of a figure approximating to two thirds of a sphere; in the upper joints and in the smaller cells of the secondary and their lateral rachises they are of a figure nearly hemispherical (or kettledrum-shaped); and by degrees, as the cells diminish in size down to the smallest, they assume a nearly plano-convex figure, until finally, in the very smallest cells, they appear like mere dots, or brightish rounded or discoid granules. In all, it may be said, there is a more or less evident slightly projecting *rim* around the flat side, which rim often presents a slightly crenulated appearance (Pl. XXVIII. fig. 12). In those of the smaller dimensions and of a plano-convex figure, however, the margin appears to be somewhat "bevelled off," and the crenulations forming an inner series. The convex or hemispherical surface is always quite smooth, and even glossy in appearance; in dried examples it may become more or less broken or altered. The substance appears of a colourless, semitransparent consistence. It is the plane side which is apposed to the opening of the pits, than which it is a good deal larger, closing it up like a lid—the

convex surface being towards the cavity of the cell. Strictly speaking, that portion of the superficies had better be called truncate rather than plane, as, especially in the larger examples of these bodies, it can readily be seen to be hollowed out or excavated in a rather irregular manner (Pl. XXVIII. figs. 11, 16, 18). Sometimes this hollowing out is a mere simple concavity; or this may show at its middle a secondary depression, or even a tertiary somewhere about the middle of the secondary, with sometimes a narrow inlet, then roundly expanding within. Thus the more or less irregular excavation may sometimes reach to a depth of a half to three quarters of the thickness of the whole body, but more frequently to only a quarter to a third the depth. Sometimes the excavation is nearly vertical laterally, and its bottom flat, in place of forming a concave depression, whilst that of an interior median secondary depression may be rounded or flat; and sometimes (though rarely) a narrow perforation may even pass right through to the hemispherical surface. In the larger examples especially, the inner surface of these inwardly variously shaped, though usually at their periphery pretty nearly circularly bounded excavations is seen to be not smooth but rough, even rugged, and of a somewhat granulated aspect.

When the two knob-like covers or stoppers are undisturbed *in situ*—that is to say, placed directly opposite to one another, each upon the opening of its own pit, and thus closing it up—and when the two together are viewed in conjunction with the outline of the two pits forming, as it were, a canal slightly narrowing halfway from one knob to the other, the whole offers a very curious and singular resemblance to a "rivet," as it were binding together the neighbouring joints; for the canal of the double pit is sufficiently deceptively like the shank of the quasi-rivet, the variously figured stoppers (as described) passing for its "heads," which clamp the structure on both sides. But when, as often happens, the stoppers become dislocated (see woodcut, p. 230), the quasi-stalk (that is the double pit) of course remains, dispelling an illusion of which the observer might at first glance be pardonably enough the victim.

These stoppers did not offer any evident reaction in presence of the usual tests for starch and cellulose; they disappeared totally on the specimen being boiled in caustic potash.

They are, so to speak, external to the so-called "primordial utricle," yet in intimate contact or union therewith. One could occasionally see the cell-contents still closely adherent to the convex surface of a stopper, partially contracted, and stretched into a conical shape, more and more expanding in width away from the stopper. Oftentimes the tension so induced caused the dislocation and pulling away of the stopper still coherent with the mass of plasma; or it might be "let go" halfway; at other times, and indeed more frequently, the cell-contents contracted, leaving the stopper *in situ*. In otherwise seemingly empty cells the stoppers, if not in their places (see woodcut), as is very frequently the case, could be found lying about in any part of the cavity and in any position. By their comparative dimensions one might safely enough predicate the particular pits to which they doubtless had belonged, and whence they had become dislocated (Pl. XXVIII. fig. 3).

But on examining the organization of this pretty alga, and in trying to gain a know-

ledge of the remarkable structure of which I have been endeavouring to convey an idea, one soon encounters an appearance, at first a very puzzling one, which, especially when viewed under a low power of the microscope, is readily misleading. Prof. Wright was the first to suggest the true solution of the contradictory appearance alluded to. But before I try to describe this, it will be necessary to convey an idea of the external or lateral form of the joints of the stems and rachises.

The cells of the "*stems*" and of each *principal* and *secondary rachis* of Mr. Moseley's plant are about $\frac{1}{2}$ to $\frac{1}{3}$ as broad as long, and of a figure which has somewhat the aspect of an elongate oval (Pl. XXVIII. fig. 3). When more closely studied, especially under a higher power, they are seen to be of a cylindrical form for about $\frac{3}{5}$ or $\frac{2}{3}$ their length from the base, at which point they become narrowed upwards, but in such a manner that thence to the summit the outline on each side gradually assumes a somewhat sigmoid curve, the inward flexure at the upper portion being greater and somewhat more arched than that at the lower. In other words, at the place where the nearly cylindrical lower portion of the cell ceases it becomes gradually contracted; the outline, however, does not form any angle, but is rounded off and is thence continuously curved inwards, then upwards for a time almost vertically, soon imperceptibly beginning to be uninterruptedly, but more rapidly, curved inwards on each side to the summit. The diameter of the cells at the summit is usually about $\frac{2}{5}$, or sometimes less, or it may be, on the other hand, nearly $\frac{1}{2}$ of that of the cylindrical portion. I have called the lower portion of the cells nearly cylindrical; but they are not absolutely so, as they generally seem to be very gently and gradually concave on the lateral margins, the concavity being deepest about halfway from the base to the point where they become narrowed upwards. On the whole they mostly appear to be very slightly dilated from the concave middle to that point; that is to say, the widest part of the joint, by some very slight degree, is that just before where they begin to be narrowed by the sides curving inwards. So much for the contour (be it always understood of the cells of the principal stems and rachises) presented in the ordinary view, so far as relates to their external (that is lateral) boundary.

I say, the ordinary view presented; for the habit of this plant being repeatedly distichous, the principal stems, branches, rachises, and their pinnæ or ultimate terminal offshoots, all lie in pretty nearly a common plane; hence a portion detached, however small, almost necessarily comes to be viewed from one or other of its plane aspects. The description given above of the lateral contour applies, it will be of course understood, to the joints so viewed.

Now when they are examined in that position, the lower end of each joint of the principal stems and rachises seems to be of a more or less conical figure, and broadly and bluntly rounded at the extremity, and as if projecting downwards into the joint immediately below; the upper portion of the latter necessarily introverted to receive it (Pl. XXVIII. figs. 3, 10, 11, 14, 16; Pl. XXIX. figs. 15, 18). Not only has the structure the appearance described, but (if we are viewing this alga under a higher power) a slight alteration of focus further shows the base of the joints as broadly rounded off at a higher level, and as if the apex of the joint immediately below it were in close apposition

thereto. If the plant be viewed under a low power, the two contours—the broadly rounded and the deep conical—come into view nearly simultaneously, and we have the curious and contradictory appearance of the joints having, as it were, *two bottoms*; and this is what gives rise to the puzzling appearance alluded to. Now the *pits*, with their accompanying remarkable *knob-like stoppers, are seen to occur in the nearly transverse septum over the seeming conical base.* If there were a conical base of the upper joint, passing down into and introverting the tip of the joint immediately below, how could the knob or stopper of the upper end of the lower joint get past the barrier, and become opposed, on its own pit, to that at the bottom of the upper joint? Without any opening or passage, manifestly it could not be so deposited in its proper place.

The curious appearance of the introversion of the upper end of the lower joint might, indeed, possibly meet its explanation by assuming an interspace, from this ordinary aspect of a bluntly triangular or conical figure, between the two joints; somewhat comparable to the very differently shaped interspace between the mutually introverted ends of several forms of *Spirogyra*, but in the present plant, indeed, only one (the lower) joint being introverted. But even if this were true, it would not explain the pair of directly opposed "knobs;" for one would be at the base of the upper joint, and the other must then be in an "intercellular space," and therefore outside the cavity of the lower joint, thus offering really no explanation, and in truth presenting a puzzle just as difficult of solution as ever.

The fact is that the apparent introversion of the upper end of the lower joint by the lower end of the upper joint projecting downwards into it, an interpretation which naturally occurs to every one on first looking at this plant, is illusory.

So illusory is it, indeed, that Harvey himself, in describing his *Ballia Brunonia*, directly falls into the error, and quite misapprehends the true state of affairs *. He actually describes the structure, speaking of the joints of the rachis, thus:—"Articulus singulus apice concavus, basi convexus, superior in inferiorem insertus, e cellula unica formatus, sacculam *endochromæ* includens;" and afterwards he says, "each joint is concave at its superior end, convex at its inferior, having thus a somewhat cordate figure, the convex end being inserted into the joint immediately below it, while the concave receives in like manner the one above. These joints consist of a single cellule, and contain a bag of colouring matter which is collapsed in a dry state." As will be seen, the true structure is quite the reverse of Harvey's description; whilst he is altogether silent as regards the pits and stoppers, whatever be their value or significance. Nor does it appear that subsequent authors had detected the fallacy or noticed these curious "stoppers."

The true explanation is, that the lower end of each joint is in fact deeply cleft or forked laterally—that is, forming two wedge-shaped subdivisions; and these latter are tapered off towards each front, more or less conically, and then truncato-rotund, or rounded off subhemispherically. To some extent it might not be altogether inaptly compared to the top of a bishop's mitre.

* Harvey, "Description of *Ballia*, a new genus of Algæ," in Hooker's Journal of Botany, 1840, p. 190.

Now, having before described the mode of narrowing upwards of the upper ends of the joints and their lateral contour (in " ordinary " view), it remains to say further that they are from both front aspects narrowed upwards—so as to offer a blunt wedge-shape, rounded at tip, if they were viewed laterally—and so as to fit into the deep similarly figured notch of the lower end of the joint immediately above. The boundary at the summit is somewhat concave, adapted to the convex base of the interior of the notch of the joint above; but as it is considerably narrower, its concavity does not so readily strike the eye, and it might be regarded as straight or nearly so. Thus each joint might be said to be, as it were, equitant upon or to sit astride the wedge-shaped top of the joint immediately below; its more or less tapering or narrower subdivisions (one of which is seen in either ordinary " front view " of the frond) giving rise to the at first pardonable enough error, that there is a projection into and introversion of the cell immediately below.

Thus the true state of affairs is just the reverse of what one naturally is first inclined to imagine; it is the base (not the summit) of each joint which is introverted to make room for the tapering upper end of the joint immediately below it. But this introversion takes place in the peculiar manner and gives rise to the configuration described—this, as it were, " splicing together " of the joints doubtless adding to the tenacity of this rigid alga. That this is the true explanation I have satisfied myself by breaking up a small portion of the plant, and as much as possible denuding little fragments of their branches; and I thereby succeeded in getting a lateral view of a filament, otherwise necessarily, as has been mentioned, extremely difficult to obtain. In this view the marginal contour of a filament is pretty nearly straight from end to end (Pl. XXVIII. fig. 9).

From the description already given it will be observed that—owing to the narrowing upwards with a curved outline of the upper ends of the joints of the principal stems and secondary rachises, and to the peculiar figure presented by the basal end of the joint above it, coming down to meet it with the curve appertaining to the inner angle of the great " notch " therein—opposite each " splice " there exists what may be called a recurring narrowing of the filament (Pl. XXVIII. figs. 3, 14; Pl. XXIX. figs. 13, 17).

Owing to the peculiar contours of the joints being ignored in the figures extant, as a matter of course these shallow sinuses are not represented; the lateral margins are shown rather as those of broadly truncato-ovate cells. Still less is there any indication that, as is the case, each of these shallow sinuses is filled by a cell (Pl. XXVIII. figs. 3, 10, 11, 14; Pl. XXIX. figs. 17, 18). When fully formed, this intervening cell appears to be either quinquangular or sexangular, but in different parts of the plant of very varying proportional figure. And it is from this cell—never directly from the rachis-joint itself—that the lateral branches take origin.

These lateral cells, which I would denominate " ramification-cells " are either pentagonal or hexagonal; and the five or six sides (as the case may be) are of very unequal lengths. Two of the sides are apposed to the joints of the rachis; two beyond these are external and always unchanged; and the one or two remaining sides intervene between it and a ramification. The longest side in the pentagonal cells is that in apposition with the whole of the curved (that is, attenuated) upper portion of the joint of the

rachis. The next longest is that opposite thereto, external, and forming with the first an extremely acute angle (2); the third longest is that forming an obtuse angle with this latter; and on it (3), as will be explained, stands the first joint of a branch; the fourth in length is that in apposition to the curved interior of the great notch in the lower part of the joint (4); and the shortest (which is very short) is that joining the last with the second longest (or that side bearing the branch) (5). When there are six sides the relative length of the sides is the same, and the additional side (6) is nearly equal in length to, and immediately under, that bearing the primary branch, and is itself (as will be explained) surmounted by a minor shorter (stipule-like) branch.

Now the mode of origin of these ramification-cells is seen to be by the formation of a peculiarly *curved septum* at one or (mostly) both sides of the joint of the rachis, previously cylindrical, or nearly so, all the way from its base to its summit—this septum beginning at its lower extremity from the point, about three fifths or two thirds from the base of the rachis-cell (before described), and ending at its upper extremity a little within the base of the joint immediately above (Pl. XXVIII. fig. 5). This septum (1) takes a sigmoid curve as viewed from above, and is at the same time hollow or concave towards the ramification-cell, convex towards the rachis-cell, imparting the peculiar shape to the latter, as previously described. The cell thus cut off from the rachis-cell, as will be seen (it will of course be understood, when viewed from the "front"), at first forms a scalene triangle—one side only, however (the outer), being quite straight, its lower end very attenuated, and its angle there very acute.

In the formation of this septum we again encounter the curious character of an opposite pair of pits with their stoppers, every pit having its corresponding opposite fellow, the likeness of a "rivet" being still carried out (omitted in the diagrammatic figure 5). The pair of pits in the new septum is placed about one third of the way upwards from the acutely angular bottom of the ramification-cell (*a*, fig. 10). Just as this cell is much smaller than the joint of the rachis, so the pits, with their stoppers, are much smaller than those at each end of the latter. If ramification-cells are formed (as mostly, or indeed nearly always happens) at each side of the joint of the rachis (when formed at all), then the latter has two opposite lateral pits in its wall, in addition to the terminal; if only one ramification-cell be formed, then, of course, it has only one lateral pit. At this point, of course, the ramification-cell itself has but one pit—that is, the one opposite to and forming the fellow of the lateral pit of the rachis-joint.

The ramification-cell now soon grows out laterally in an inflated manner towards the upper end, the convex outgrowth being directed obliquely upwards (figs. 5 and 10). If viewed inverted, its noselike upper portion thus produced is now cut off by a curved concave septum, the concave surface being upwards—that is, the convex surface towards the cavity of the ramification-cell. The interposition of this septum makes the ramification-cell now five-sided—one of the sides (as before mentioned) being bounded by the septum just formed, the two adjoining sides, between which it intervenes, being the outer exposed portions of the ramification-cell now pushed out laterally, the upper one remaining very short and never further altered; whilst the two remaining sides are, of course, those (as before mentioned) in apposition with the lower portion of the upper joint of the

rachis, the other in apposition with the longer portion of the lower joint of the rachis respectively.

The upper (subhemispherical) portion of the ramification-cell, thus cut off by the curved, hollowed, oblique septum, is the *first joint* of a simple branch or (it may be eventually) of a subsidiary rachis (Pl. XXVIII. figs. 10 & 11). Before taking leave of this cell for the present, it is only necessary to say that at the middle of the septum is formed a pit—a double pit, it will be, of course, understood, each with its stopper. At this point, then, the five-sided ramification-cell has now, of course, two pits—one, as explained, opposite the corresponding pit of the rachis-cell, the other (younger) corresponding to the pit of the basal cell of the branch; and as the former pair of pits, with their stoppers, are smaller than those at the ends of the rachis-cell, so the latter, in their turn, are smaller still than the former.

A ramification-cell having reached this point may seemingly remain permanently so (in Mr. Moseley's plant many, by far the majority, do so); but certain of them proceed further.

If then they proceed to further development, the next stage is that from a point from about a third to scarcely half way from the outer side of the septum, cutting off the first branch-joint from the ramification-cell, a fresh curved and hollowed septum is produced; this extends thence to about the middle of the lower and outer free and exposed (external) side of the ramification-cell, its concave side outward—that is, its convex side (as before) towards the cavity of the ramification-cell (6, in figs. 10 & 11). This latter has now reached the six-sided form above mentioned. Obviously the portion cut off therefrom is at first triangular, with only one exposed or external side—this being, in fact, the upper portion of the lower free and external side of the primary ramification-cell, which lower portion whereof still forms one of its boundaries, and of course still free and external. Again, we have to note the formation in this second septum of the opposite pairs of pits and their stoppers, occupying a position about one third of the distance from the lower end of the septum. The primary ramification-cell at this point, it will be seen, has now three pits—the third and last formed being that in the freshly formed septum, and placed at a point about a third of the distance from its lower end, and opposite to which it has its fellow pit and stopper.

The triangular portion so cut off (which has one pit, with its stopper, in the septum between it and the other ramification-cell, being that first mentioned), like its predecessor, grows out at first laterally, and then obliquely upwards in a roundly inflated manner, this projecting portion being soon cut off by a fresh septum in such a way that the lower remains as a five-sided cell. This latter may, in fact, be denominated a ramification-cell of the second degree ($r\ c^2$, figs. 10 & 11); and the upper portion cut off therefrom forms the basal or primary joint of a secondary or accessory branch—the septum so cutting it off bearing again its medium pair of pits and stoppers, still smaller in size.

The five sides of the ramification-cell of the second degree, when the basal cell of the accessory branch is cut off, are thus made up:—1st. The upper portion of what was once the outer free side of the ramification-cell of the first degree, now pushed out laterally and obliquely ($1''$); 2nd. The septum cutting it off therefrom ($2''$); 3rd. The

portion of the septum cutting off the first joint of the upper branch from the ramification-cell of the first degree (3″); 4th. The (whole of the) septum cutting off the first joint of the lower branch from the ramification-cell of the second degree itself (4″); and, 5th, a very short side joining the two latter together, produced by the turning aside of the outgrowing extension of the ramification-cell of the second degree in its less advanced stage (5″).

Leaving this lower minor or secondary branch (as in the case of the older and upper one) for the present, we come to a point whence it is far more difficult to follow out the structure.

On taking up the description of *Ballia callitricha* (Ag.), Harvey, as given by Agardh under the name *Sphacelaria callitricha*, the plant he had in view is thus, in part, described: "*Caule filis confervoideis vestito*" * . . . . So also Prof. Harvey refers to the external "plexus of filaments."

On looking at a piece of our plant, these "fila confervoidea," or filaments, are indeed a prominent, but a very confusing feature, clothing, as they do, with a dense and intricately matted and tangled jungle the whole of the principal stems and some of the secondary rachises, the free ends of the filaments sticking about in every direction. This clothing might call to mind a tree densely covered with ivy, or, perhaps more fitly, might suggest a moss coated with *Chroolepus aureum*, only that the latter plant, when investing the moss, makes a smooth pile.

The authors referred to seem not to have investigated the relations of this plexus of "confervoid filaments" to the more handsome distichously branched *Ballia*-plant. I therefore desired the more to try to "make head or tail" of the confusing object before me, so far as regards the accessory clothing of what might be regarded as the *Ballia* proper (Pl. XXVIII. figs. 1, 4, 15; Pl. XXIX. fig. 14).

Not to speak of the general appearance and the similar thick-walled character of the cells of these filaments, two characters would set aside any possible supposition that these were not really part and parcel of the make-up of the *Ballia*. One of these was the presence in every one of the here directly transverse septa, separating their comparatively short quadrate joints, of a minute pair of pits with their stoppers (Pl. XXVIII. figs. 6, 7); the other, that when they branched it was seemingly by the interposition of a ramification-cell, but not of the same figure as those of the distichous stems and branches as described (figs. 6, 7).

Looking more closely into the build-up of this clothing of the stems and some of the rachises of the plants, it is readily enough seen that this is most dense at the lower portions, less and less so towards the upper portion of the plant, until it at last is wanting. It is also readily enough seen, by focusing "through and through," that at the lower portions the main stems are covered all round by a single layer of thick-walled elongate cells, mutually closely apposed, of various irregularly curved and crooked figure, or even somewhat rugged within—and that these cells are separated by *oblique* septa, these *latter* furnished with their median minute pairs of pits and stoppers, sometimes an extremity of some of the cells growing on so as somewhat to overlap the adjoining

* 'Icones Algarum,' no. vi. (t. 6).

one, their apices rounded. Thus this cortical stratum of cells somewhat resembles a kind of pleurenchymatous or prosenchymatous tissue. As our examination is carried from below upwards, this cortical stratum becomes more confined to the margins, leaving more or less of the stem-joints bare at the middle, until by-and-by it disappears altogether.

Here and there, with patience, one can probably meet with a profile view of the point whence the cells of this pleurenchymatoid cortical stratum is given off from one of the multitudinous branches which stick about most confusedly in all directions. In Mr. Moseley's plant these seem scarcely ever themselves to become branched, but form only indefinitely long "confervoid" filaments. Whilst, as mentioned, the septa of the vertical cortical cells are oblique, those of the branches given off therefrom are ever transverse; but, like those of the former, every septum here, again, has its minute pair of pits and stoppers. Only occasionally one can get a satisfactory profile view of the place of ramification; and it can be seen that this process here too is sometimes brought about by the intervention of a "ramification-cell." But this does not maintain the same figure as that of a rachis-cell as above described. Here, however, as there, an oblique, sometimes curved, septum is formed just under one of the ordinary oblique septa of a cortical cell, reaching from a point, say, about a quarter of the length of the septum from the outer wall to a short distance down the lateral margin of the cortical cell. Thus a minor cell is cut off, forming in this view a scalene triangle, two of its angles being acute, one obtuse. Soon the upper portion of its free side (being in fact a portion of the original outer margin of the cortical cell itself) grows out laterally, and, by apical growth and repeated subdivision of its apical cell, gives rise to one of the long accessory filaments, every septum, as mentioned, having its pair of minute pits and stoppers. The cells gradually diminish in size; in other words, the filaments gradually taper. The apical cell, when full-grown, is conical, its apex acuminate; but until then the apical cell is bluntly rounded. Whether, on the occasion of the giving-off of these lateral branches a ramification-cell is always formed, or whether they sometimes branch off without that preliminary by a simple outgrowth, merely standing off, as they sometimes seem to do, like a thumb to a glove, I could not decide.

So much for the ramifications of the cortical cells and the mode in which they themselves coat the principal rachises. Within one of these, so coated, one can see, by focusing down, shimmering through the investing cortical layer, the great pits and stoppers of the largest size, as well as the contours of the joints, with their ramification-cells giving off subsidiary rachises. These latter project through the cortical stratum of cells; and by far the greater number of these subsidiary branches themselves are naked. At a first glance, the question might propound itself, why do the investing fibres "run up" only a few of the subsidiary branches, and not all? why are they so much more dense low down, as compared with the upper portions of the stems and such rachises as they do invest?

This leads to the inquiry, What is the origin of the cortical cells (we have seen the origin from them of their lateral branches), and what their relation to what may, as before, be called the "*Ballia* proper"? And this is just an inquiry to which it is very

hard to obtain a reply; nor do I think that, without the opportunity to examine a *Ballia*-specimen kindly sent me by Professor Thiselton Dyer (also from Kerguelen's Land, collected by the Rev. A. E. Eaton) (Pl. XXVIII. figs. 13–18), I should have been able to satisfy myself on this point from the specimen in Mr. Moseley's collection, owing to the extremely crowded and nearly impenetrably dense investing envelope.

To try to follow out, then, the relation of the cortical cells to the rachises they invest, we must now revert to the ramification-cells of the second degree before described.

These we left as so many five-sided cells—that is to say, after the formation of the septum cutting off therefrom the portion destined to become the first joint of the lower minor accessory branch. In certain of these yet another curved septum makes its appearance: this, as might be expected, from the later period of its formation, is, by comparison, thin; and I have not been able to see in it the usual pit (or pair of pits); but I would not say that they may not be there (Pl. XXVIII. fig. 11, *x*). This septum reaches from a point about one third of the distance from below upwards of the septum cutting off the first cell of the accessory branch, to very near the lower angle of the cell (ramification-cell of the second degree). It is much curved, and has its convex side upwards or towards the cavity of the cell, and its concave side towards the portion cut off. The upper portion is, as will be seen, still five-sided, the new side (made by the new septum) being considerably arched. This portion seems never again to divide or grow in any way, thus as if of no further moment ($r\ c^2$, fig. 18). The lower portion cut off therefrom is at first subtriangular or subquadrangular, one side exposed—that is, external (being the lower outer one of the original ramification-cell of the second degree, as previously described); the other a portion (scarcely one third) of the septum, cutting off the first joint of the accessory branch; and another the new curved septum—which latter, if it gradually passes as far as the lower angle, causes the new cell to be trilateral; if, however, it terminates (ere it reaches that) somewhere near the angle, and against the adjacent side of the ramification-cell of the first degree, then we have a cell of quadrilateral outline. This last cell then, as will be seen, when it is produced, might possibly correctly be called a ramification-cell of the *third* degree ($r\ c^3$, fig. 18).

The next stage seems now to be, that the outer lower margin of this ramification-cell of the "third degree" becomes, as it were, somewhat abruptly pushed or bulged out downwards at about its middle point—this bulge soon, however, taking a more outward and lateral direction, the thick membrane becoming somewhat doubled upon itself. Sometimes one might fancifully suppose that this doubling outwards laterally got some assistance by a mechanical "dint" from without (*x*, fig. 17), imparted a little to one side of the nearly similar bulge from within; for the outline now shows this twice bent appearance. This doubling upon itself, backwards and outwards, becomes more pronounced; the lower portion becomes enlarged and inflated; and soon there is presented a large ovate external addition to this ramification-cell of the third degree (*cort. cell* 1, figs. 17, 18). This accession, in length downwards (alongside of the rachis-cell below), is about equal to that of the older portion above when first formed, and in width twice as great as that of the original portion; at the same time this additional ovate external

portion is now itself about twice as long downwards as broad. This point attained, now another septum is formed, of peculiar curvature, and stretching into the cavity of the large ovate new extension thereto, and thus, whilst it cuts off the larger portion, still leaves the ramification-cell of the third degree larger than it was originally—in fact, nearly twice the size. Having progressed so far in the examination, the structure becomes more and more difficult to follow. However, the septum last mentioned seems to take a curve from a point opposite to the sudden outer doubling back of the wall, and with a considerable sweep (something like the curved hook of a "note of interrogation") then passes quickly round to a point pretty nearly opposite the lower angle of the ramification-cell of the first degree. Thus the ramification-cell of the third degree, viewed in connexion with the portion added to it, has acquired a somewhat sigmoid curvature, the extremities broadly rounded; or it presents the figure of a subcylindrical cell with bluntly rounded apices, somewhat suddenly twice bent near the middle. Now, in the *lower portion cut off* (after forming this curved cell, and not belonging thereto) we have the first cell of a dependent appressed filament, thereafter elongating and repeatedly subdividing by oblique septa, and contributing to form the cortical stratum described. The cells go on so growing until they reach the node below, and there seem to divaricate. But the bent cell above seems to have more to do: it sends a protuberance out from each side (that is, towards each "front" of the flat frond of the *Ballia* plant), each of these forming a basal joint of further dependent cortical filaments, which, by passing downwards somewhat obliquely, cover more of the front of such main stems and principal rachises as proceed to this development (*cort. cell* 2, figs. 17, 18). At what point the very first septum is formed I could not make out exactly. Arguing from the analogy afforded by the mode of branching lower down, I suppose a septum is very early interposed upon the formation of a convex expansion, at both "fronts" (of the frond) of the lower portion of the bent cell—such septum cutting off that portion as the first joint of the cortical filament, which is dependent at each side of that previously described, these two having the latter between them, one running down on one front of the frond, the other on the other aspect.

It seems, however, sometimes to happen that no septum is formed in the ramification-cell of the second degree, and thus no portion thereof is cut off behind as useless; but the process described can go on, this omission notwithstanding. There is then no ramification-cell of the "third" degree formed. That of the second degree having had cut off from it the first cell of the lower accessory branch, proceeds to develop from its basal portion, by the outgrowing thereof and formation of the curved septum as described. The extreme lateral cortical filament, and at both front surfaces (of the frond), gives off the protuberances (keeping the former between them as described), which grow into further cortical filaments, directed more across the front aspects of the rachis as described.

The mode of branching of the dependent cortical cells is by repeated dichotomy. Close to the rounded apex of the terminal cell two septa are formed (making a V); these of course cut off two chords or cells of at first plano-convex figure, which, expanding and elongating downwards, grow side by side as the first joints of two collateral branches. As the filaments grow downwards, occasionally thus branching, they cover first the margins, then more and more of the frontal surfaces of the stem; and they keep closely

apposed to one another and to the cells of the stem or rachis, leaving (especially lower down) very few "intercellular spaces" (that is, intermediate bare places of the stem). When these occur they are of irregularly acutely lanceolate outline. The largest intercellular spaces are those, of course, through which the lateral branches or subsidiary rachises project—left necessarily by this descendent investing cortical stratum of cells as they pass downwards to each recurrent node or joint of the great stem or rachis, and from each of which in the same way new ones are given off in their turn.

If a lateral rachis possesses such a cortical stratum of cells, they belong to and emanate from its own nodes; for such dependent cells on arriving at a branch never become directed upwards to cover it, but the system passes downwards by the same stem to the base. The cells forming this cortical stratum soon begin to give off their own branches (as described), and more and more copiously as they descend, until the great confused tangled "plexus" is produced.

In order to complete the description of Mr. Moseley's plant we must now briefly revert to the ramification. We left the basal joint of a principal branch just formed by the cutting-off of the same from the ramification-cell of the first degree; and, in the same way, we left the first joint of a minor or accessory branch just formed by the cutting-off of the same from the ramification-cell of the second degree; but not all, indeed comparatively only a few, of the ramification-cells proceed to this latter development. The greater number of the ramification-cells remain as of the "first degree"—that is, five-sided; and the cell cut off gives rise, by continuous apical elongation and repeated division, to a more or less long (sometimes very long), often very stout, filament. There is in such cases no septum producing a ramification-cell of the second degree formed; and therefore no basal or accessory branch originates (Pl. XXVIII. fig. 3, its upper part).

Each branch so emanating from a principal stem has (it need hardly be said) nearly always a similar one opposite thereto, arising, as described, from its own ramification-cell; and from every node for long distances such a pair of branches may be thus distichously given off. But it sometimes happens that a branch may be without an opposite corresponding one: the lateral margin of the side so deficient remains straight from bottom to top; no ramification-cell is cut off—no branch (parts of fig. 2).

And just in the same way in Mr. Moseley's plant these lateral branches (pinnæ) may be, and often are, quite simple for the whole of their length (that is, with linear sides), no ramification-cells being cut off, therefore no pinnules formed.

But the overlapping of the laterally subdivided bases of the cells towards both fronts of the frond is more or less carried out in the joints of the lateral branches. The base of the first cell of a branch arising as described, and of each succeeding one, is, like that of the rachis-cells, laterally notched, but comparatively not at all so deeply: thus, like them, each cell sits astride the upper portion of the cell below; that of the first cell so bestrides, of course, the adjacent side of the ramification-cell. The basal subdivisions of the cells of the branches which partially overlap the cells below, one on one front, the other on the other front of the frond, however, are not so prolonged and so conically tapered off downwards as are the cells of the principal stems or rachises, but are rounded off subsemicircularly, or with a merely convex outline. Still those nearer the base of

the branch or lateral rachis are more deeply overlapped (in the manner described) than are the upper cells. As one proceeds upwards the overlapping is seen to be less and less pronounced; that is, the curve downwards in front of the subdivision of the bases of the component cells of the branch becomes less and less arched; whilst near to or at the top they appear hardly at all to overlap.

The cells very gradually diminish in size upwards; in other words, the branches gradually taper. The increase in length of the branch is effected only by the growth and subdivision of the terminal cell, the next lower cell never subdividing again (unless, of course, it should produce ramification-cells). During the progress of the growth of the branch the terminal cell appears to be rounded at the top; but when the branch attains its full length, and apical growth is over, the terminal cell becomes drawn out, long and conical, its summit acuminate, and its membrane thickened.

I may add that the cell-membrane, especially of the principal stems or ramifications, appears to be irregularly and longitudinally distinctly, though faintly, striate.

With the exception of the "stipule-like" secondary branchlet (given off from the ramification-cell of the second degree), the pinnæ (in Mr. Moseley's plant), in comparison with other forms, very seldom ramify; that is, they give off pinnules only here and there very fitfully. However, this lower external branchlet, unlike an ordinary pinna or pinnule, as has been seen, is not an ultimate emanation from the same series of cells (or, in other words, from the same subsidiary ramification) as the pinnæ proper, but it is a collateral and ultimate emanation from a series of cells (forming a main stem or a ramification) of a generation back. This collateral or accessory ramification, then, is as much an independent branch as the older one above, although it might (in error) be taken for a pinna springing therefrom. But inasmuch as this accessory branch is but a subsequent emanation, primarily owing its origin to the ramification-cell of the second degree, which in turn was formed by the subdivision of the primary ramification-cell, it could not therefore exist without having been preceded in time by the (larger) branch immediately over it, at the outside base of which it stands.

The secondary or subsequent rachises in Mr. Moseley's plant, and their simple branches or pinnæ, are usually pretty stout, taper very slowly, and stand off from one another at an acute angle, here and there often in a very scattered and irregular manner, giving off solitary branchlets, or little groups of pinnules—it need not be said, each ever preceded by a ramification-cell. It will be seen, then, that we have a plant of a considerably long-drawn-out and fastigiate habit. Though the branches and pinnæ lie pretty much in a common plane throughout, still the plane may be more or less altered through the extent of the aggregate formed by a plant of, say, a few inches in length (Pl. XXVIII. fig. 2).

It would be a very difficult matter, perhaps hardly possible, to trace out correctly the different layers or laminæ of the very thick walls of the rachises up into their ramifications. It seems that an outer layer of possibly numerous thin laminæ, forming a portion (the upper) of the original wall of each joint of a stem or rachis, reaching from below upwards, becomes diverted laterally, and thus continued forms the *outer layer* of the lower exterior wall of the ramification-cell. But soon afterwards, owing to the

tension to which it has been subjected during the outgrowth of the latter and of the ramification seated on it, it becomes gradually "thinned off to nothing" and, excepting any little of it left higher up (the mere softened or macerated remains), totally disappears. Its seeming (and why I say "seeming" only, will appear below) total disappearance is hastened when a ramification-cell of the second degree is formed, owing to the more sudden lateral diversion and increased tension of this layer caused thereby. The inner stratum of the free side of the ramification-cell of the first degree is deposited simultaneously with, inasmuch as it is a continuation of, that septum, shutting off therefrom the ramification-cell of the second degree; and it is carried onwards round the interior of the ramification-cell of the first degree. The lower portions of this layer converge towards the acute base of the cell, and there, mutually apposed, seem to pass vertically downwards in a very compressed state; moreover as a single layer between the outer layer of the base of the stem- or rachis-joint (from which we started) and an internal layer, which passes round the interior of the rachis-joint and at its upward parts (on both sides usually), it cuts off therefrom the ramification-cells of the first degree. Now when a secondary branch has fully grown, if we carry our examination upwards along the exterior of the primary branch (secondary rachis) immediately over the former, we see an outer layer somewhat sharply marked off from the inner, and this likewise "thinned off to nothing" upwards. Now I believe this layer was once in continuation with that below the subsidiary "stipule-like" branch, and which latter, as we saw, is (and of course always was) in continuation with the lower external layer of the stem- or rachis-joint itself; that is to say, it had been in continuation therewith prior to its having been forced asunder by the continued stretching and tension caused by the growth in the first place of the ramification-cell of the second degree, and afterwards of the branchlet seated thereon. Further, this upper outer layer last alluded to must have itself once formed part and parcel of the upper part of the original wall of the stem- or rachis-joint, anterior to the formation of the septum cutting off therefrom a ramification-cell of even the first degree—from whose expansion laterally it got its first impetus outwards, far away as it has now been transported from the place where it was originally deposited. And this is why I spoke of its seeming disappearance. Suppose now that the basal joint of a branch goes on to produce a ramification-cell (and a branchlet), we find immediately over the same a piece of external layer "thinning off to nothing" as before; this latter, again, must have been, I presume, pushed up and out from the ramification-cell just below it, and previous to that have formed so much of the upper portion of the basal joint of the branch, and so on. Possibly it may be assumed that something similar occurs, were it traceable, in ordinary branching confervoids; but so common is a gelatinous softening of the outer layers in such, that any traces of the mutual superposition of laminæ get lost.

On comparing this plant with examples of *Ballia callitricha* from the University herbarium, kindly placed at my disposal for comparison by Dr. Perceval Wright, one is at once struck by the very great difference in habit between the two. Indeed the same observation holds good as regards the further forms or species *B. Hombroniana* and *B. Brunonia*, distinguished by some from, and by others combined with *B. callitricha*.

I leave the thoroughly distinct forms of *B. Robertiana* (Harvey) and *B. Mariana* (Harvey) out of view, not having investigated them with sufficient pains to be able to contrast them in their relative bearing to the points presented by Mr. Moseley's plant; but confining our attention to those forms combined under the designation *B. callitricha*, we see they are all of beautifully more or less well-developed plumose habit, very unlike Mr. Moseley's form. It would, however, be trenching on rather unsafe ground for me to venture to distinguish this plant as a new species.

In *B. callitricha* and the forms conjoined with it under that designation, the whole that has been said in relation to Mr. Moseley's form, as regards the pits and stoppers, the ramification-cells and mode of evolution of the branches and cortex, in a general way applies. The differences in the different forms lie in the various figures of the different constituent cells forming the build-up of the plants, until we come to the ultimate pinnæ with their pinnules. Unlike Mr. Moseley's plant, where these ultimate pinnules are rarely and only fitfully given off, in the *B. callitricha* forms they are methodically and pretty uniformly given off from the cells of the ultimate little rachis—*always by interposition of a ramification-cell* of the first degree only, and so as to produce a plume of ovoid or lanceolate or hastate outline, according to the " species."

It becomes worthy of remark that whatever the outline of these plumes, and consequent effect or habit of the plant in its entirety, the lowest outer component thereof, looking like a pinnule of the same nature and origin as the rest, is not really so, but is in fact the homologue of the lateral " stipule-like " secondary branch described in Mr. Moseley's plant:—there mostly, or at least often, solitary; here, along with the close array of pinnules, contributing to make up the " plume," and rendering itself quite conformable with the true pinnules. That is to say, it is a true secondary branch, being an emanation from the ramification-cell of the second degree belonging to the older rachis from which that bearing the pinnæ starts, as this latter is an emanation from the preceding ramification-cell of the first degree; and from the ultimate minor rachis standing thereon, in turn there emanate all the pinnules standing above this secondary branch, which is conformable with the pinnules, and forms part and parcel of the " plume."

It sometimes, indeed, happens that this lower branch grows inordinately in length, refusing to comport itself like the line of pinnules above it; I did not, however, ever notice a case in which it branched or gave off secondary pinnules or " pinnellæ." In Mr. Eaton's form, sent by Prof. Dyer, the inordinate growth of this accessory branch seemed more common.

The ultimate terminal or apical "plume" of each ultimate rachis in the typical *B. callitricha* must, however, be excepted; for its pinnæ are wholly made up of short stout tapering branchlets, each standing on a ramification-cell, all of the first degree, a continuation of the penultimate rachis being its rachis. In other words, these do not go on to become ultimate rachises themselves, do not produce ramification-cells, hence no " pinnellæ;" but together they form an apical "plume," of more or less lozenge-shaped general outline; and sometimes the upper cells remain inactive, produce no ramification-cells, and do not ramify. Sometimes, indeed, one or two of these apical pinnæ (branchlets) may make an attempt from a few of their cells to give off ultimate pinnellæ,

though these sometimes reach only the formation of a ramification-cell—as indeed the effort to produce pinnellæ at the apices of some of the plumes lower down may get no further than the same preliminary stage.

In the "typical" form the ramifications given off from the cortical stratum are much more prone themselves to branch than in Mr. Moseley's. Several branches (from three to ten) are given off, generally alternately, in quick succession, and radiate in a kind of fan-like manner; each possesses always a preceding ramification-cell (five-sided when the branch is formed), as in Mr. Moseley's plant. The pits and stoppers are present, but not so conspicuously evident.

The differences between the "typical" *B. callitricha* and *B. Hombroniana* are very graphically shown in Mr. Tuffen West's delicately rendered drawings. More distinct still than they are from each other, appears Mr. Moseley's plant from either.

At first glance, *Ballia scoparia*, Harvey, seems hardly to belong to the same genus. Distinct as is the habit, and divergent as is this plant in several details from the preceding forms, there is still a good deal in common; but possibly, after all, the same characteristics may yet be found to be more forcibly presented in other algæ. So far as regards the pits, they are not confined to *Ballia* in Rhodophyceæ; these, as "pores," have long ago been pointed out by Nägeli. It is the "stoppers" (so called) which I fancy to be new.

Now in *B. scoparia* the pits are generally pretty evident, the stoppers not readily seen, presenting themselves as only little thin discoid bodies (Pl. XXIX. figs. 3–9). It likewise possesses a plexus of threads on the principal stems, of which more below.

Like the former, this species branches by interposition of "ramification-cells;" but these and the mode of branching are quite dissimilar.

Its general habit is aptly enough indicated by Dr. Harvey's specific name:—long-drawn-out and fastigiate; the "branches" scarcely thinner than the "stems," most irregularly given off at no particular intervals, and only at one side, and branches fitfully again branching (Pl. XXIX. fig. 2). The branches stand off with a slight curve from the cell on which they originate, and then proceed upwards at an acute angle to the "stem." The ends of the joints appear to be slightly hollowed; and the adjacent upper and lower ends mutually somewhat overlap, the outer lower margins being convexly rounded (figs. 8, 9). The upper portions of the branches give off unilaterally a succession of a few (1–5–6) of short spine-like uncinate bluntly acuminate branchlets (fig. 3); and when these are formed, that branch which bears them grows upwards no more; that is, its terminal cell ceases to subdivide, and its apex becomes acuminate, like the lateral spine-like branchlets.

Now the formation of the ramification-cell is puzzling. When a young one is viewed edgeways, it seems to form a lenticular hollowing in the thick wall of the joint (fig. 6); but how that could so originate is very questionable. It may be formed by a deposition of membrane all round the joint, but so as to shut out a portion of the "contents," which assumes that figure. Viewed from the "front" (fig. 9), this as yet very thin cell is seen to be of broadly elliptic figure, showing a minute sharply marked pit and stopper exactly in the centre. More grown, and viewed edgeways, one of these cells appears

much inflated inwardly towards the cavity of the joint, the median pit at least readily enough made out (Pl. XXIX. fig. 5).

It seems sufficiently surprising the comparatively considerable number of cases in which no further development appears to ensue. Sometimes one can trace three or four of these ramification-cells in as many joints in immediate succession at various parts of a " tuft " of this alga, and frequently in other places scattered here and there a single one. Possibly the rate of growth may be but very slow; and many of those incipient ramification-cells apparent in a given example probably would have gone on, were the plant undisturbed in its native habitat, to the development at some later period of further ramifications.

This process seems to take place simply by the projection of the outer side of the ramification-cell in an inflated manner (fig. 5), gradually expanding in an upward direction. When about half the length of an ordinary joint is attained, a septum is formed, the apex grows onwards, then a fresh septum, and so on, until the definite length of the branch is attained; the upper joints finally give off the acuminate spine-like branches, and the apical cell becomes itself almost spine-like and acuminate.

From the peculiar figure, as described, of the ramification-cell the branch has somewhat the appearance as if it issued through a lateral cleft of the wall of the joint bearing it; and the original inner convex boundary of the ramification-cell, being wider than the portion issuing from the side of the joint in which it is seated, lends to the whole much of the appearance of being a kind of graft, as it were, let in at that side of the joint whence it emanates (fig. 8).

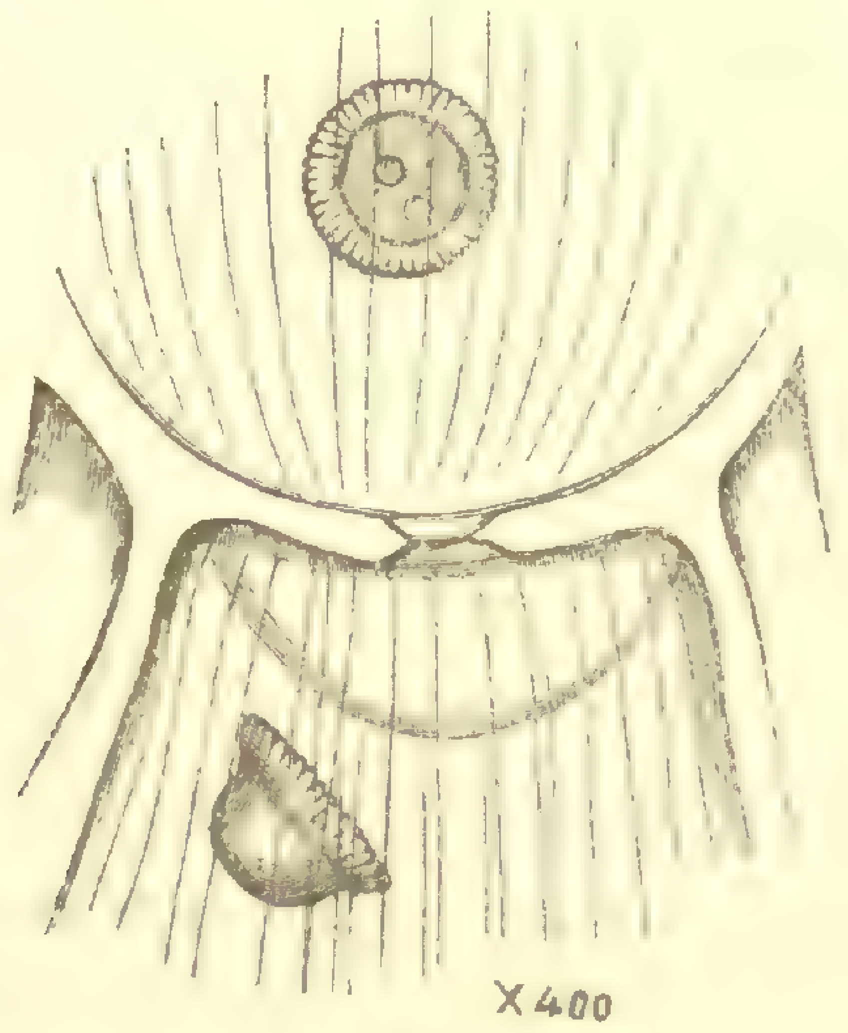
Notwithstanding that the mode of origin of the ramification-cells here seems to differ from that in the cortical cells of Mr. Moseley's plant, still, when the branching is effected, there is a sufficiently striking similarity in appearance in the "graft-like" aspect of the insertion of the ramification, and in the mode in which it stands off from the joint bearing it (Pl. XXVIII. fig. 7).

Towards the lower end of the plant decurrent branches are given off somewhat similar to those in the *callitricha* group; but here they do not seem to form a close "cortex." Their mode of origin seems to be very similar to that of the ordinary branches; but I was unable to alight on an example in as early a condition; primarily the ramification-cell seems to be similar.

The ramification-cell here, however, when the decurrent branch is formed, does not seem to offer as much of the appearance of a "graft" let in at the side as does that of an ordinary branch (Pl. XXIX. figs. 10, 11). When it is fully formed it appears of a broadly ovate figure truncated below—that is, cut off there by the septum, dividing from it the next joint of the dependent branch; its inner lateral margin projects in a convex manner towards the cavity of the joint whence it emanates; and its outer boundary projects in a convex manner towards the surrounding medium. But this cell is always subdivided by a septum (x, in figs. 10, 11) into two unequal portions, the origin or significance of which I have been unable to make out. This septum runs in a curved manner, its convex side inwards, from about the upper apex (the whole plant being viewed vertically) of this truncato-ovate cell to near the outer lower angle (formed by the outer

bounding wall and the first transverse septum alluded to); it thus cuts off a portion (the outer and smaller) of doubly convex figure (? in figs. 10, 11) from the other portion (the inner and larger) of triangular figure, bounded, however, by two curved lines and one straight (*r c* in figs. 10, 11). The septum, concave towards the latter, and separating it from the original joint, possesses its minute pair of pits and stoppers; so does the flat septum separating off the first joint of the decurrent branch, as well as the subsequent septa; but there seems to be none in that septum, convex towards this triangular cell, which cuts off the lenticular portion alluded to. At what period this latter peculiar septum is formed, or for what purpose, as I have said, I could not make out; and it remains to me one of the puzzles connected with this plant. It seems, as it were, like a "ramification-cell" which never, however, goes on to produce a branch.

The apical cell, whose *punctum vegetationis* has impressed upon it the downward impetus, continues to grow onwards, repeatedly dividing by a transverse septum. It is not long ere this dependent branch begins itself to ramify; perhaps even the very first-formed joint may produce a ramification-cell quite like those of the ordinary erect branches; and, as in their case, often "ramification-cells" are present that do not seem to go any further. When ramifications are formed, which, indeed, is still very frequent, they stand off more approaching a right angle than do the ordinary branches (see Pl. XXIX. fig. 4); and they have the same "graft-like" appearance; the subsequent septa are transverse, and the pits often very obscure. Towards the base of the plant ultimately a dense irregular plexus of branching filaments is in this manner produced.



Drawing, in outline, of a joint of the stem from a portion of Mr. Moseley's example of *Ballia callitricha*. It shows the junction and coadaptation of the two cells, their partial invagination and the seeming double bottom, the double pit, and the pair of stoppers thrown out of position. One of the latter appears in profile; the other exhibits its truncate side or that surface which is apposed to the opening of the pit. Magnified about 400 diameters.

DESCRIPTION OF THE PLATES.

PLATE XXVIII.

Illustrations of the minute structure and mode of growth of *Ballia callitricha.* Figs 1–12 are from the fragments of this alga, gathered by Mr. Moseley, of H.M.S. 'Challenger,' in Kerguelen's Land. Figs. 13–18 are from those obtained in the same island by the Rev. A. E. Eaton, during the Transit-of-Venus Expedition, and placed at the author's disposal by Mr. W. T. Thiselton Dyer.

Fig. 1. A portion of Mr. Moseley's plant: natural size.

Fig. 2. A portion of same, showing its habit and the fitful manner in which the ultimate branchlets are given off, and the paucity of any thing like the regular "plumes" of the other forms: × 20.

Fig. 3. A smaller portion, more highly magnified. The lower part of the figure shows the 6-*sided* ramification-cells, which therefore bear, besides the ordinary pinnæ (branches), the accessory minor branchlets. The upper part of the figure shows the 5-*sided* ramification-cells, which therefore are without the accessory branchlets. In some of the joints of the rachis the stoppers have become dislocated, and lie apart within the cavity. × 50.

Fig. 4. A node or joint of a rachis, showing the dependent cortical investment and the bases, with the intervening "ramification-cells," of four simple branches (*i. e.* without the accessory ones), the two lower being, of course, at the top of the next abutting joint beneath; the opposed pairs of stoppers can be seen above and below, the stopper at the top of the joint having become slightly displaced. × 100.

Fig. 5. Diagrammatic figure (founded, however, upon a young growing branch actually observed), showing the youngest and more advanced conditions of the ramification-cells. The letter *i* is placed against the septum in each case produced to cut off the triangular portion of the rachis-joint to become the ramification-cell. The letters *r c* indicate in all cases the "ramification-cell." The growing apical cell is still rounded; when fully formed it becomes acuminate.

Fig. 6. A branch given off from a cortical cell—that is to say, one of the component filaments of the great plexus standing off from a main stem or principal rachis: greatly magnified.

Fig. 7. Another filament giving off a branch in two places, also highly magnified: *r c,* ramification-cell.

Figs. 8, 9. Side views of a node of a rachis under a still higher power.

Fig. 10. Diagrammatic figure of the mode of growth of the ramification-cells, founded on cases actually observed in specimens: $r\,c^1$, ramification-cell of the "first" degree; $r\,c^2$, of the "second" degree. The figures 1–6 represent the different sides of the cell as adverted to in the text; *a a,* lateral pits and stoppers of the joint-cell; *b,* the terminal pits and stoppers.

Fig. 11. Similar but more advanced, showing now the base of the accessory branch (hence necessarily the ramification-cell of the second degree) fully formed. The figures $1''$–$3''$ represent the different sides of this cell, as adverted to in the text (the figures 1–6 and the letters *a* and *b* as in preceding). These two figures indicate the manner in which the projections from the base of each of the joints overlap and sit astride upon the apices of the joints below, thus giving rise to the old error that they passed down into a pocket-like introversion of the same.

Fig. 12. A stopper of large size, seen from its flat surface.

Fig. 13. The Rev. A. E. Eaton's plant, of natural size.

Fig. 14. Same magnified, showing habit; near the top the branches simple, lower down showing

accessory branchlets (the ramification-cells with the change mentioned in text), lower down still the branches showing pinnæ. × 50.

Fig. 15. A portion of same plant more magnified. The branches have (all but one, which remains simple, having formed no ramification-cells) become secondary rachises; and the ramification-cells of the principal rachis have given off cortical cells: these have not yet completely clothed the rachis, in fact only on the sides; nor have they given off any lateral branches. In one place (fitfully enough) the ramification-cells on each side of a secondary rachis have given off cortical cells. The large pits and stoppers of the median rachis are very prominent; they are much smaller in the secondary rachises, gradually diminishing in size upwards, smaller still and gradually diminishing in the collateral branchlets and pinnæ, but, though reduced to mere dots, are always present. × 50.

Fig. 16. A small portion, similar to fig. 15, more magnified. × 100.

Fig. 17. Diagrammatic figure of the first cortical cells.

Fig. 18. Diagrammatic figure of the commencing growth of the cortical cells from the ramification of the "third" ($r\ c^3$); "cort. cell 1" indicates the first lateral cell, and "cort. cell 2" *one* of the *frontal* cells, which lay the foundation of the cortex, indicated in figs. 15 and 16.

PLATE XXIX.

Fig. 1. Tuft of *Ballia scoparia,* of natural size.

Fig. 2. A portion of a plant, × 50.

Fig. 3. Diagrammatic figure of the extremity of a branch, showing two spine-like thickened acuminate branchlets, the apical cell also spine-like, thickened and acuminate; the pits and stoppers very minute and nearly obsolete.

Fig. 4. Mode of branching of cortical cells in this species.

Fig. 5. Commencement of a branch by the outgrowth of the lateral ramification-cell (*r c*).

Fig. 6. A stem or branch with a secondary branch, showing edge view of two ramification-cells (*rc*, *rc*).

Figs. 7, 8. The mode in which the branches appear as if inserted.

Fig. 9. A ramification-cell (*r c*), seen from the front, showing its elliptic figure (lenticular in edge view, see fig. 6) and central pit between it and the parent joint.

Figs. 10 and 11 show the mode of giving off of the dependent "cortical" cells from the principal stems: *r c*, the ramification-cells; *x*, the septum cutting off the lenticular cell (marked ?), of questionable purpose. In fig. 11, at *a* occurs one of the ultimately numerous branches going to make up the confused plexus seen in some specimens. They frequently show here and there the formation of the lenticular ramification-cells. It would have been better if fig. 11 had been inverted to indicate the dependent direction of these cortical ramifications.

Fig. 12. *Ballia callitricha* (typical): nat. size.

Fig. 13. A spray of this beautiful plant, × 50, showing its elegant closely set "plumes."

Fig. 14. Showing cortical investment: × 25.

Fig. 15. Same more highly magnified: × 100.

Fig. 16. Portion of *Ballia Brunonia,* of nat. size.

Fig. 17. Part of the same specimen, × 50. (Mr. Eaton's plant seems to accord more with this form.)

Fig. 18. Small portion, still more highly magnified: × 100.

W. Archer.

STRUCTURE & GROWTH

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XIV. *On the Geographical Distribution of the* Meliaceæ. *By* M. CASIMIR DE CANDOLLE, *of Geneva.* (*Communicated by* G. BENTHAM, *Esq.*, *F.R.S.*, *V.P.L.S.*)

(Tab. & Map=Plates XXX. & XXXI.)

Read April 19th, 1877

HAVING just completed a revision of the whole order of Meliaceæ, it has occurred to me that a general survey of their geographical distribution would not be devoid of interest. It would certainly be premature to aim at any thing like precise lines of demarcation of the areas of the species themselves in the case of plants so thoroughly exotic, considering that, most likely, a great many new species or new stations of known specific forms remain yet to be discovered. But, on the other hand, we have good reason to suppose that very few genera will have to be added to those already admitted.

When A. de Jussieu, in the year 1830, published his classical monograph of Meliaceæ and Cedrelaceæ, he had to deal with 135 species, which he distributed into 34 genera. At the present time our herbaria contain more than 560 species, forming only 35 genera. It is true that 10 of the generic names originated by Jussieu have been given up since, as founded on insufficient grounds, whilst more modern authors have created as many as 12 new genera. But it is to be remarked that those 12 new genera, taken together, do not include more than 38 distinct species; consequently more than 380 new forms belong to genera already admitted by A. de Jussieu. It is, in particular, worthy of notice that South America, which has been so much explored by modern botanists, has yielded only one new genus of Meliaceæ since A. de Jussieu's time, that genus (*Elhuteria*) being hitherto represented by a single species.

This being the case, it seems that a study of the geographical distribution of the genera of that family is not uncalled for; and I will now proceed to state at once the principal results to which such an investigation has led me.

Nearly all Meliaceæ actually known inhabit the countries situated between the tropics, beyond which their number is found to decrease very rapidly. South of the equator their area seems to be limited to the 30th degree of latitude, the only exceptions that I know of being *Trichilia peruviana*, which has spread as far south as Chile, and *Dysoxylum spectabile*, the single representative of the order in New Zealand on the 40th degree.

In our hemisphere spontaneous Meliaceæ have not hitherto been observed north of the tropics, with the exception, however, of *Cedrela sinensis* and *Aglaia odorata*, which have been collected in the neighbourhood of Pekin, on the 40th degree, and two species of *Melia*, indigenous in the southern part of Japan. Moreover it is well known that *Melia Azedarach*, a plant most likely derived originally from India or Tropical Africa, has from time immemorial been introduced into all countries bordering on the shores of

the Mediterranean, while *Cedrela sinensis* is now cultivated in the open air, in the Jardin des Plantes at Paris.

The existence of these few eccentric stations, in both hemispheres, clearly demonstrates that the fact of the Meliaceæ being confined to intertropical or subtropical regions is not to be accounted for solely by the present climatic conditions, and must, to a great extent, have resulted from other more remote causes of a geological nature. But this is a consideration on which I need not dwell, since it is so thoroughly in accordance with the modern notions of geographical botany.

A general view of the distribution of Meliaceæ is shown in a map (Pl. XXXI.) accompanying this paper, the coloured and shaded portions of which indicate the regions where that order is more or less represented. A dark green line, drawn round the outer extremities of those regions, embraces their whole area, including even such eccentric and exceptional stations as Pekin or New Zealand.

A first inspection of this map would rather lead to considering South America the principal centre of habitation for the Meliaceæ, as they here occupy a larger continuous area than in any other part of the world. But it will presently be shown that the study of the geographical distribution of all the genera composing the family points decidedly to a totally different conclusion.

In order to arrive at a satisfactory conception of the case as it stands, I have drawn up a synoptic Table (Pl. XXX.) of the number of species of each genus in all the countries where Meliaceæ are known to exist.

On the left of the Table is a list of the genera, 35 in number, following each other according to their morphological affinities; whilst in the upper part I have entered the names of all the various countries which are to be taken into account. Those names are written in their geographical order from west to east, beginning with Chile on the left, and ending with the Navigators' archipelago on the right side of the Table.

For the sake of greater precision, the principal provinces of South America are recorded separately one from the other, Africa and Australia being also subdivided into less extensive regions. The western peninsula of India, or India proper, is, for the same reason, kept apart from Birmania and Malacca, which are grouped together with Cochin-china. Finally, more distinct, but relatively small, regions or islands have also been grouped together, such as Columbia with Venezuela, Borneo with Celebes, &c.

Before taking into consideration the contents of the synoptic Table, it is necessary to offer a few remarks concerning the nature of the various genera to which it refers. It will be observed that, with the single exception of *Azadirachta*, A. Juss., all of them have been admitted by Dr. Hooker, in Bentham and Hooker's 'Genera Plantarum,' as well as subsequently by Dr. Hiern, in his important contribution to the flora of British India. On the other hand, in conformity with Miquel's and with Dr. Baillon's views, some few of the generic names contained in the above-mentioned 'Genera Plantarum' have been given up. I have, however, retained the genus *Walsura*, which Dr. Baillon has joined to *Heynea*, and the name *Dysoxylum*, which corresponds to his *Epicharis*. Thus we find that, with very few exceptions, all the genera referred to in my synoptic Table

have, independently of my own researches, and after careful scrutiny, been also admitted by the highest authorities on the subject. Consequently I do not hesitate to consider them as being thoroughly natural.

To return to the figures contained in the Table, it is evident that each of the horizontal series formed by them furnishes us with a complete statistical representation of the geographical distribution of one genus; at the same time a continuous thick, dark line drawn round the extremities of all such horizontal series enables us to understand clearly the relation which exists between that geographical distribution and the morphological affinities of the various genera.

A first result becomes thus manifest. We are at once struck by the fact that the greatest number by far of the genera of Meliaceæ are to be found in the central part of the Table, whilst on the sides there are only a few generic forms presenting but a slight mutual affinity. In other words, we may say that the American and East-Polynesian genera, rare and very distinct, are morphologically connected by a series of numerous intermediate forms, all concentrated in the Asiatic regions or in their neighbouring archipelagoes. It is, for instance, a positive fact, that out of the 35 genera composing the whole order, no less than 26 are represented within the limits of the western coast of India on one side, and of the eastern shore of Australia on the other.

We also observe that, with the exception of *Melia* and *Cedrela*, these various genera are very much localized, the figures corresponding with each of them forming only short horizontal series in the synoptic Table. With respect to the genus *Melia*, its exceptionally large area is more apparent than real, being due, for the most part, to the wide spreading of a single species, namely, *Melia Azedarach*, which is not to be considered indigenous out of Tropical Africa and India. I have consequently left all the other stations of that species outside the continuous line including the genus, which is thus reduced to a very moderate area. The genus *Cedrela*, on the other hand, extends in reality over a vast surface; but it must be observed, at the same time, that there exists a striking morphological difference between the American and Indian or Australian species, a fact which could not, however, be made apparent in the Table.

Another general conclusion to be derived from the synoptic Table is the great analogy which exists between the Polynesian and the Asiatic *Meliaceæ*. In fact, we see that all the Polynesian species, excepting *Vavæa Amicorum*, belong to what may be termed the Indian type of Meliaceæ—that is to say, to genera which are represented in either one or the other of the Indian peninsulas.

With regard to Australia, the case is somewhat different. Besides many species belonging to the Indian type, that continent contains also two genera (*Owenia* and *Lansium*) which belong exclusively to it; and moreover ten out of the eleven species composing the genus *Flindersia* are hitherto known only in Australia. Although the whole tribe of Melieæ, so abundant in Tropical Africa, is entirely missing in South America, there exists, nevertheless, a striking analogy between the types of those two distant continents. Not only are the three genera *Trichilia*, *Carapa*, and even *Guarea* represented in Africa as well as in South America, but, moreover, *Carapa procera* is actually common to the west coast of Africa and the Guianas.

No less remarkable is the total difference existing between all the American Meliaceæ and those of the most eastern parts of Polynesia,—not a single American species, not a single American genus, being hitherto represented further west than the westerly slopes of the Peruvian or Columbian Andes, and all Asiatic genera having, as above mentioned, not been found further east than the Navigators' Islands. It is, however, to be observed that the Brazilian genus *Cabralea* posseses the closest affinities with the genus *Dysoxylum*, which is spread all over Polynesia—a fact which might, perhaps, suggest some amount of analogy between the American and the Indian types; but at the same time it is to be observed that the genus *Cabralea* is exclusively confined within the southern provinces of Brazil, none of its species having hitherto been found on the western side of the Andes.

I pointed out at the beginning of this paper how premature it would be to take into serious consideration the exact boundary-lines of the species of Meliaceæ. Some general remarks, however, bearing on this part of the subject are not altogether out of place. As might have been expected, the insular species are in general very much localized. A striking illustration of this consists in the fact that 18 out of 19 species of *Dysoxylum* inhabiting New Caledonia are special to that island, a single one of them existing also in Australia and in other parts of Polynesia. On the other hand, some species are remarkable for the great extent of their areas. For instance, *Sandoricum indicum*, (*Maingayia*) *marginatum*, and *Chisocheton paucijugum*, which are all of them indigenous in the Malayan peninsula, have also been found in Java, and even as far east as Borneo. Again, *Trichilia havanensis*, *Guarea filiformis*, *G. trichilioides*, *Swietenia Mahagoni*, and *Cedrela Glaziovi* are common to the West Indies and several provinces of South and Central America.

In conclusion, the chief features of the geographical distribution of Meliaceæ may be summed up briefly as follows:—

1. The number and the mutual affinities of the various genera of Meliaceæ are found to decrease gradually from the Asiatic regions towards Africa and America on one side, and towards Eastern Polynesia on the other.

2. There exists a marked analogy between the American and the African Meliaceæ, whilst all the Polynesian species and genera of the order belong to the Indian type.

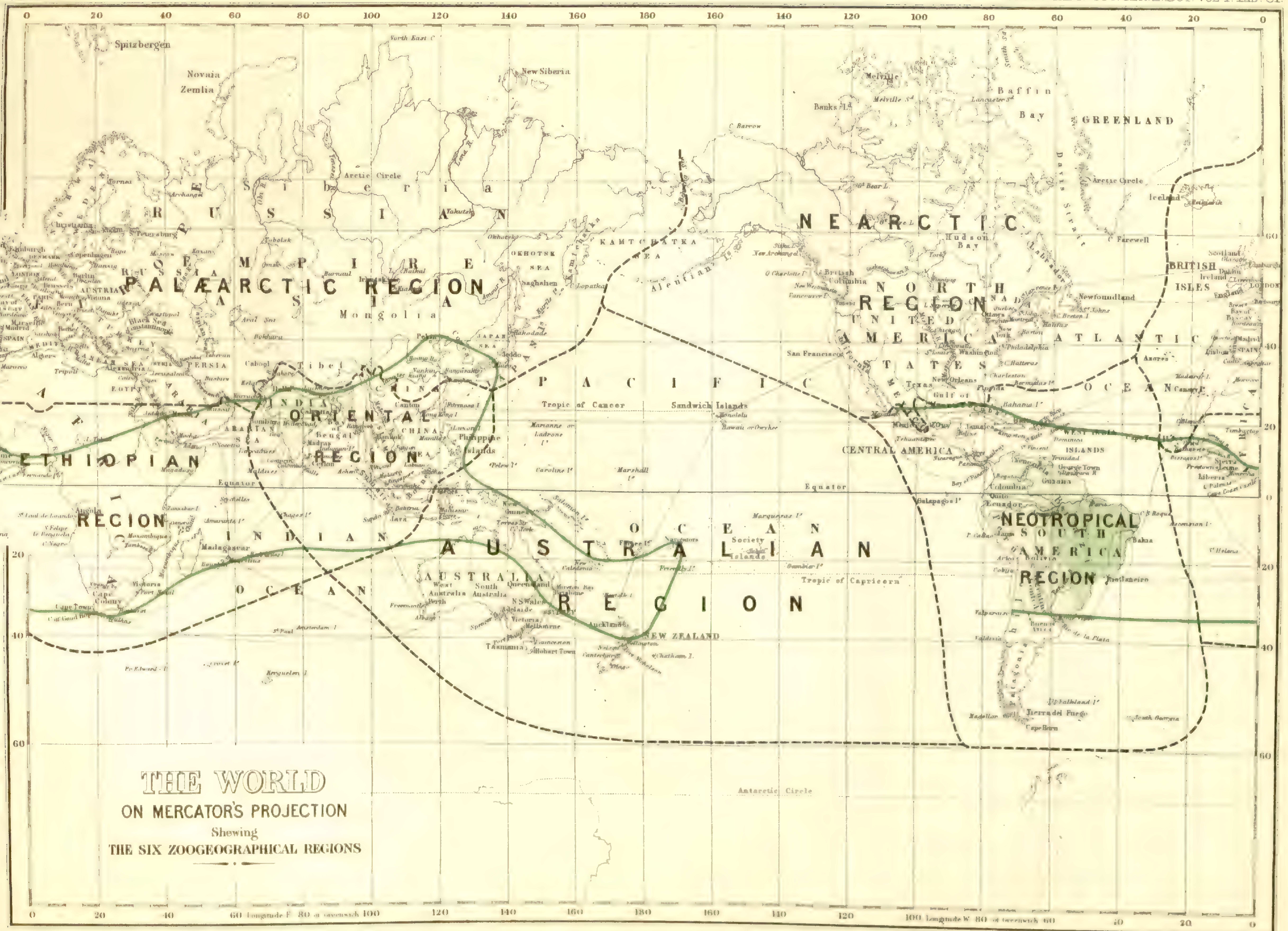
3. New Caledonia contains a remarkable number of very distinct species, all of which, except one (*Flindersia Fournieri*), belong to the Indian type, though they are exclusively to be found in that island.

4. In Australia we find three Indian genera, *Turræa*, *Dysoxylum*, and *Cedrela*, associated with the three genera *Owenia*, *Synoum*, and *Flindersia*, which, with the exception of a single species (*Flindersia Fournieri*), belong exclusively to that country.

5. No species of Meliaceæ have hitherto been collected in the most eastern islands of Polynesia—that is to say, further east than the Navigators' group. It is, however, hardly credible that the order should be entirely absent from the Sandwich or Galapagos archipelago. Should subsequent explorations reveal the existence of Meliaceæ in those islands, it will be interesting to know whether they belong to the Indian or to the American type.

TABULAR ARRANGEMENT ILLUSTRATING THE GEOGRAPHICAL DISTRIBUTION OF THE GENERA AND SPECIES OF THE MELIACEÆ, ACCORDING TO M. CASIMIR DE CANDOLLE.

		Chile.	Peru.	Columbia and Venezuela.	Panama.	Central America.	Mexico.	Guianas.	Brazil.	West Indies.	West Tropical Africa.	Cape.	East Tropical Africa.	Madagascar and Mayotte.	Bourbon and Mauritius.	India (western peninsula).	Ceylon.	Andaman.	Birmah, Malacca, and Cochin-China.	Sumatra.	Java.	Borneo and Celebes.	China.	Japan.	Philippines and Molucca.	Timor.	New Guinea.	North Australia.	East Australia.	New Caledonia.	New Zealand.	Fiji.	Navigators' Islands.
MELIEÆ.	CIPADESSA													2		1																	
	QUIVISIA													3	5																		
	TURRÆA										2	3	3	5		3					3		1						1				
	TURRÆANTHUS												2																				
	NAREGAMIA										1					1																	
	MUNRONIA															1	1				1					1							
	MELIA	1	1	1	1	1	1		1	1	2	1			1	2	1		2		2			2	2	1			1			1	
	AZADIRACHTA															1					1												
TRICHILIEÆ.	SANDORICUM														1				3			5			1								
	CABRALEA								30																								
	DYSOXYLUM															7	1		7	4	18	4			4	3	5	1	9	19	1	1	1
	CHISOCHETON															1–2			9	2	3	3			2								
	GUAREA		10	6		2–3	4	10	43	6	1																						
	AMOORA															5	2		8	1	2	2			2	2			1	2			
	DASYCOLEUM																					2				2							
	OWENIA																											1	4				
	SYNOUM																												2				
	LANSIUM															1			3		1												
	BEDDOMEA															2																	
	AGLAIA														1	6	3	3	11	13	15	9	1	7			2		1	1		1	1
	HEARNIA																					4			3								
	WALSURA															2	3	4	3														
	EKEBERGIA										5	2	2																				
	VAVÆA																															1	
	TRICHILIA	1	8	14	2	4	8	11	48	15	8	1																					
	HEYNEA													1		1			2	1													
SWIETENIEÆ.	CHUKRASIA															2			1														
	KHAYA										2																						
	SWIETENIA		1			1	1				1																						
	ELUTHERIA			1																													
	SOYMIDA															1	1																
	CARAPA					1		2	1		2			2	1		1		2		2				2				2	2		2	
CEDRELEÆ.	FLINDERSIA																								1?				9	1			
	CEDRELA		1	2			1–2?	1	4	2			1			3	1		1		1		1						1				
	CHLOROXYLON															1	1																



GEOGRAPHICAL DISTRIBUTION OF THE MELIACEÆ

XV. *New British Lichens. By the Rev.* W. A. Leighton, *B.A. Camb., F.L.S., F.B.S.Ed., &c.*

(Plate XXXII.)

Read December 7th, 1876.

Lecidea impressula, Leight. *Albido-cinerascent, thin, filmy, rimulose, nigro-limitate.* (K *yellow, then red.*) *Apothecia black, minute, punctiform,* numerous, crowded into small groups of 3 or 4 or more, *impressed or sunken in the thallus, each apothecium circumscissed so as to appear surrounded by a thin thalline margin*; hypothecium thin, nigro-fuscous; paraphyses indistinct, apices colourless; hymenium tinged with brown; *spores* 8, *fuscous, rotundo-oblong,* 1-*septate,* more or less constricted in the middle.

On bluish-grey slates, rare, 1876.

Gelatina hymenea I dirty blue. Spores ·014–·0145 mm. long, ·009 mm. broad. Several plants grow on the same stone, and by the union of their dark hypothalli map out the surface as in *L. geographica.* Allied to *L. stellulata,* Tayl., but distinct by the thin filmy thallus, larger spores (one third larger), and the singularly impressed apothecia.

Llanachar bridge! and Fort Hill!, near Fishguard, Pembrokeshire (1876); Festiniog road, near Dolgelley!, North Wales. Moel-y-gest! near Tremadoc.

Lecidea tephrizans, Leight. *Thallus* nearly *obliterated,* only a few whitish depressed scattered areolæ remaining; (K – C –;) *hypothallus cinerascent, predominating; apothecia black,* numerous, plane or slightly concave, *prominent, sessile,* moderate; margin thickish, eventually obliterated; *hypothecium nigro-fuscous, subtended by a pale greyish-blue hyaline excipulum*; *hymenium thin, pale greyish-blue*; paraphyses distinct but cohærent, apices nigro-fuscous; *spores* 8, *colourless, narrowly ellipsoid, simple, minute.*

On hard slaty rocks, rare, 1876.

Spores ·009–·01 mm. long, ·004–·005 mm. broad. Spermatia minute, shortly cylindrical, straight. Gelatina hymenea I dirty blue.

Llanachar bridge! near Fishguard, Pembrokeshire (Sept. 1876).

Lecidea ryssolea, Leight. *Albido-cinerascent, thick, tartareous, diffracto-areolate; areolæ* plane or subplano-convex, *irregularly wrinkled,* nigro-limitate. (K yellow, then red.) *Apothecia nigro-fuscous, opake,* somewhat rusty, *large, very prominent* and sessile, numerous, margin thick, paler, entire or flexuose; *hypothecium very thick, fusco-nigricant*; hymenium thin, brownish; paraphyses indistinct, apices thick, nigro-fuscous; *spores* 8, *fuscous, oblong,* 1-*septate, small.*

On Caradoc sandstone rocks, rare, 1876.

Spores ·016–·017 mm. long, ·007–·008 mm. broad. Gelatina hymenea I pale dirty blue. Medulla I–.

Fort Hill! near Fishguard, Pembrokeshire (Sept. 1876).

LECIDEA IMPONENS, Leight. Thallus obsolete; *apothecia black,* minute, numerous, *scattered, sessile,* plane or subconcave, margin thin, eventually obliterated; *pale bluish-cinerascent within*; *hymenium and hypothecium hyaline, pale bluish-cinerascent*; *excipulum horny, bluish-cinerascent, externally darker*; paraphyses thick, cohærent, apices nigricant; *spores* 8, *colourless, elliptical,* simple.

Parasitic on *Lecanora polytropa* (Ehrh.), rare, 1876.

Spores ·014–·015 mm. long, ·0055 mm. broad. Gelatina hymenea I dirty fuscescent.

Fort Hill! near Fishguard, Pembrokeshire (Sept. 1876).

LECIDEA GLAUCOMARIA, Nyl. Thallus obsolete, merely a small irregular, deformed, pale nigro-fuscous patch or discoloration, on which are the apothecia; *apothecia fusco-nigrous,* opake, clustered, *subinnato-sessile, plane, margin thickish, paler, entire, often subflexuose*; hymenium fuscescent; paraphyses indistinct, cohærent, apices incrassate, fusco-nigricant; *hypothecium nigro-fuscous, thin*; *spores* 8, *colourless, oblongo-ovoid,* 3-*septate.*

Parasitic on *Lecanora glaucoma* (Hoffm.), rare, 1876.

"Gelatina hymenea I pale blue, then vinous red. Spores ·021–·025 mm. long, ·008–·009 mm. broad" (*Nyl. Obs. Holm.* 177, fig. 10; *Scand.* 245). The apothecia sometimes form warty agglomerations. Spores ·0235 mm. long, ·009 mm. broad.

Not to be confounded with *Arthonia glaucomaria,* Nyl. (*A. varians,* Dav.), which grows on the apothecia (not on the thallus) of *Lecanora glaucoma* (Hoffm.). This lichen has been found sparingly in France and at Stockholm, but has been now detected for the first time in Great Britain.

Goodwick Bay! Pembrokeshire (Sept. 1876).

LECIDEA PARELLARIA, Nyl. (*in Flora,* 1876, p. 239). Thallus none; *apothecia black,* opake, small, scattered, single or 2 or 3 together, *sessile chiefly but not exclusively in or near the margins of the areolæ of the matrix*; *thallus* plane, *margin thickish, prominent, more or less pruinose*; *hypothecium nigro-fuscous, thin*; paraphyses indistinct, conglutinate, apices clavate, nigricant; *spores* 8, *fuscous, lineari-oblong or oblong, generally* 1-*septate, sometimes* 2-*septate, and sometimes* 3-*septate* in the same apothecium; gelatina hymenea I bluish, then fuscescent.

Parasitic on *Lecanora parella* (L.), rare, 1876.

Spores ·011–·014 mm. long, ·005 mm. broad. This interesting lichen has been found once in the West of Ireland, by Mr. Larbalestier in 1876; and it now occurs very plentifully on stone walls about Fishguard, Pembrokeshire (Sept. 1876).

LECIDEA ENDOMELÆNA, Leight. *Pale cirereo-virescent*, opake, *glebulose*; *glebulæ scattered or areolato-diffract, thick, convex, composed of minute conglomerate convex, roundish, or sublobate subfurfuraceous squamules.* (K pale yellow, C pale yellow.) *Apothecia violet-black*, rather *large*, *innato-sessile*, at first plane with a thickish margin, afterwards very convex and immarginate, *slightly pruinose, concolorous within*; *hypothecium very thick, nigro-fuscous, with a paler brown enclosed intermediate stratum*; *spores* 8, colourless, small, *elongato-ellipsoid*, simple.

On stone walls, very rare, 1874.

A very distinct species. Hymenium palish blue, I dense violet. Paraphyses cohærent, apices fuscous. Spores ·0115–·0125 mm. long, ·0045–·005 mm. broad.

ODONTOTREMA MAJUS, Leight. Whitish or evanescent; *apothecia brownish, prominent, scattered, rotundate, suburceolate*; *margin thickish, prominent, persistent, nearly entire*; hypothecium colourless or slightly fulvescent; paraphyses distinct, slender; *spores* 8, colourless, *broadly lineari-oblong*, 3-septate.

On drift wood and decorticated stumps, rare, 1876.

I renders the linear asci and spores lutescent. Spores double the size of those of *O. minus*, Nyl., ·019–·021 mm. long, ·0075–·0085 mm. broad. Spermogonia brownish, oblong, minute; spermatia oblong or lineari-oblong, ·0095 mm. long, ·003 mm. broad.

This I possess amongst the Arctic American lichens of Sir John Richardson; and now (Sept. 1876) it has occurred on drift wood in Goodwick Bay, Pembrokeshire. It has also been detected on old willow stumps at Hencote Pool, near Shrewsbury, and on wood chips in Gloucestershire.

Spores of *O. minus*, Nyl. (see fig. 15), ·0115–·014 mm. long, ·005 mm. broad. Spores of *O. longius*, Nyl. (see fig. 17), ·0195–·021 mm. long, ·005–·007 mm. broad.

VERRUCARIA NEOTTIZANS, Leight. *Apothecia black*, minute, *clustered*, hemisphærico-conical; *perithecium* carbonaceous, *entire*; paraphyses distinct, slender; *spores* 4, *fuscous, lineari-oblong*, 3-*septate, constricted.*

Parasitic on the thallus of *Bæomyces rufus*, DC., very rare, 1876.

Gelatina hymenea I—. Spores ·0245–·025 mm. long, ·0085–·009 mm. broad.

Llanachar bridge! near Fishguard, Pembrokeshire (Sept. 1876).

VERRUCARIA FUMOSARIA, Leight. *Apothecia black*, minute, *hemisphærico-depressed, semi-immersed*; epithecium poriform; *perithecium dimidiate, much incurved at the base*; paraphyses none; *spores* 8, *fuscous, broadly or rotundo-oblong*, 1-*septate.*

Parasitic on the thallus of *Lecidea fuscoatra*, f. *fumosa*, Ach., rare, 1876.

Spores ·0155–·016 mm. long, ·007 mm. broad.

Pen Cow! near Fishguard, Pembrokshire (Sept. 1876).

VERRUCARIA PERTENUIS, Leight. *Cinereo-nigricant, thin, filmy, continuous*, opake, *furfuraceous*; *apothecia black*, opake, *minute*, numerous, *hemisphærical, sessile*;

perithecium dimidiate, black ; epithecium a minute pore ; paraphyses distinct, long, thickish ; *spores* 8, *colourless, elongato-acicular, slender*, 3-*septate*.

On slaty rocks, rare, 1876.

Differing altogether from *V. chlorotica* (Ach.) in the attenuated acicular spores and other characters, as above. Gelatina hymenea I lutescent, especially asci and spores. Spores ·034–·035 mm. long, ·004 mm. broad. Spermogonia numerous, minute, verrucarioid ; spermatia excessively minute, oblong or lineari-oblong, straight.

Goodwick Bay ! Pembrokeshire (Sept. 1876).

DESCRIPTION OF PLATE XXXII.

Fig. 1. *Lecidea impressula*. Vertical section of an apothecium, enlarged.
Fig. 2. Spores, magnified 1200 times.
Fig. 3. Vertical section of the enlarged apothecium of *Lecidea tephrizans*.
Fig. 4. Spores of *L. tephrizans*, magnified 1200 times.
Fig. 5. *Lecidea ryssolea*, apothecium in vertical section, enlarged.
Fig. 6. Spores of same, magnified 1200 times.
Fig. 7. The enlarged apothecium of *L. imponens*, in vertical section.
Fig. 8. Spores of *L. imponens*, magnified 1200 times.
Fig. 9. *Lecidea glaucomaria*, vertical section of enlarged apothecium.
Fig. 10. Spore of same lichen, magnified 1200 times.
Fig. 11. *L. parellaria*, enlarged apothecium in vertical section.
Fig. 12. Spores of *L. parellaria*, magnified 1200 times.
Fig. 13. *Lecidea endomelæna*. Apothecium in vertical section, enlarged.
Fig. 14. Its spores, magnified 1200 times.
Fig. 15. Spores of *Odontotrema minus*, magnified 1200 times.
Fig. 16. Spores of *O. majus*, magnified 1200 times.
Fig. 17. Spores of *O. longius*, also magnified 1200 times.
Fig. 18. Spores of *Verrucaria neottizans*, magnified 1200 times.
Fig. 19. Spores of *V. fumosaria*, magnified 1200 times.
Fig. 20. Spores of *V. pertenuis*, magnified 1200 times.

NEW BRITISH LICHENS.

XVI. *New Irish Lichens. By the Rev.* W. A. LEIGHTON, *B.A.Camb., F.L.S., F.B.S.Ed., &c.*

(Plate XXXIII.)

Read April 5th, 1877.

PERTUSARIA INCARNATA, Leight. Thallus *creamy-white*, thin, tartareous, effuse, *smooth, plane, minutely rimuloso-diffract.* (K — C —.) *Apothecia single, of a waxy appearance, paler than the thallus, prominent*, sessile, *depresso-globose*, variable in size according to age, in maturity large; *ostiolum yellowish flesh-colour, lecanoroid*, at first small and round, poriform, eventually *dilated and urceolate, surrounded by a broad, thick, pale, waxy, thalline margin*; hymenium in section ceraceo-gelatinose, flesh-coloured; paraphyses slender, more or less branched and entangled, apices colourless; *spores* 2, colourless, *very large, lineari-oblong or ellipsoid, simple, with a very narrow limb or epispore.*

On granite rocks, very rare, Kylemore, co. Galway, Ireland, *Mr. Larbalestier* (1875).

Spores ·062–·067 mm. long, ·033–·035 mm. broad. Gelatina hymenea I violet.

This beautiful lichen is excessively rare, and apparently quite new to science. It has occurred only once to Mr. Larbalestier, whose indefatigable and skilful lichenological researches in the west of Ireland have added so many and such rare novelties to our lichen-flora. In general external aspect it a good deal resembles *Lecanora epulotica*, Ach., for which it might cursorily be readily mistaken; but the number, size, and shape of the spores and other characters keep them abundantly apart. It seems allied to *Pertusaria rhodoleuca*, Th. Fries; but that species is at once distinguished by its 8 smaller spores. *Pertusaria rhodocarpa* of Garovaglio's 'Comment. de Pertusariis Europ. Med.' p. 8, t. iv. f. 4, is like it in the large size and narrowly limbed two spores, but differs in growing on mosses, and having a verrucoso-granulose thallus and coacervate aggregate numerous apothecia. Garovaglio's plant, which he refers doubtfully to *P. rhodocarpa*, Krbr. (Syst. p. 384), cannot be identical with that German lichen, inasmuch as Th. Fries, who has examined an original specimen from Körber, 'in Lich. Scand.' p. 322, refers Körber's lichen to *Varicellaria rhodocarpa*, Th. Fr., which has an immense single 1-septate spore, and is represented in Th. Fr. L. Scand. Exs. 73! and has reaction K—, C crimson, and is altogether different in its sorediate thallus.

LECIDEA POLOSPORA, Leight. Thallus *white or albo-glaucous*, very thin and filmy, effuse, smooth, and somewhat shining, unequal or rugulose (K— C—); *apothecia black, minute*, scattered, *adnate*, plane, with a narrow slightly prominent margin, at length plano-convex and immarginate; *hypothecium nigro-fuscous*; hymenium

colourless; paraphyses distinct, thickish, apices globular, nigro-fuscous; *spores* 8, *elliptical, fuscous, with a paler fuscous roundish cell at each apex.*

On old thorn-bushes, very rare. Ballinahinch churchyard, co. Galway, Ireland, *Mr. Larbalestier* (1877).

Much resembling in general aspect *Lecidea myriocarpa*, DC. Gelatina hymenea I deep blue. Spores ·02–·022 mm. long, ·009 mm. broad. The peculiar shape and structure of the spores keep it as an entirely distinct species.

Lecidea grumosa, Leight. Thallus *evanescent*; *apothecia rufo-fuscescent, minute,* scattered, *adnato-sessile, plano-convex,* the slight margin soon obliterated; *hypothecium colourless*; *hymenium yellow, grumous*; *paraphyses altogether indistinct,* apices colourless; *spores* 8, in lineari-obovate asci, *colourless,* oblong, *simple, filled with very minute spherical granules.*

On pine-bark, rare. Ballinahinch, co. Galway, Ireland, *Mr. Larbalestier* (1877).

A very singular species. Gelatina hymenea I blue, then fulvescent. Spores ·013–·015 mm. long, ·007–·009 mm. broad.

Lecidea antrophila, Larbal. Thallus *ochraceo-virescent,* thin, effuse, *pulverulento-furfuraceous* (K— C—); *apothecia fulvo-rufescent,* small, scattered, *excessively convex* and prominent, sessile, *immarginate, a very pale narrow margin only appearing when wetted*; *hypothecium darkly fulvo-rufescent,* thick; hymenium colourless; *paraphyses indistinct, apices colourless*; *spores* 8, *colourless, linear, or lineari-oblong, simple, very minute.*

On the interior of caves, rare. Miderlin! near Kylemore, co. Galway, Ireland, *Mr. Larbalestier* (1877).

Gelatina hymenea I very pale blue. Spores ·009 mm. long, ·0025 mm. broad. A very remarkable and apparently distinct species.

Calicium kylemoriense, Larbal. *Parasitical* on a whitish thallus, apparently that of *Lecanora cinerea*, L.; *apothecia excessively minute, shortly stipitate*; *capitulum crateriform, nigro-fuscous, somewhat shining*; *stipes very short, of a paler whitish colour*; paraphyses entangled, branched; *spores fuscous or fusco-nigrescent, sphærical,* with a distinct narrow epispore, variable in size.

On shady rocks, rare. Miderlin! near Kylemore, co. Galway, Ireland, *Mr. Larbalestier* (1877).

Spores ·006–·008 mm. diam. A very beautiful new species.

Verrucaria Larbalestierii, Leight. *Thallus albido-glaucescent,* thin, tartareous, effuse, *minutely rimuloso-diffract*; *areolæ plane, smooth, somewhat shining,* having 1 or 2 apothecia in the centre of each areola; (K yellow, C—;) *apothecia black, moderately large, semi-immersed, internally dark, nigro-fuscous*; ostiolum hemi-

sphærical, prominent, shining; epithecium a minute depressed pore; *perithecium black, entire*; *paraphyses none*; *spores* 8, *fusco-nigricant, oblong*, 1-*septate, minute.*

On granite rocks, rare. Near Kylemore! co. Galway, Ireland, *Mr. Larbalestier* (1877).

A delicately beautiful species, to which I give the name of its talented discoverer. Spores ·016 mm. long, ·008–·0085 mm. broad. Gelatina hymenea I —.

DESCRIPTION OF PLATE XXXIII.

Fig. 1. *Pertusaria incarnata.* Enlarged view of the thallus, to show the peculiar structure, the position, and the nature of the apothecia.

Fig. 2. Vertical section of apothecium of the same, enlarged.

Fig. 3. Spores of the same lichen, magnified 600 times.

Fig. 4. *Lecidea polospora.* Vertical section of apothecium, enlarged.

Fig. 5. Its paraphyses, also very considerably enlarged.

Fig. 6. Spores of the same lichen, magnified 1200 times.

Fig. 7. *Lecidea grumosa.* Vertical section of an apothecium, enlarged.

Fig. 8. Ascus of *L. grumosa,* enlarged.

Fig. 9. Spores of the same lichen, magnified 1200 times.

Fig. 10. *Lecidea antrophila.* Section of apothecium, enlarged.

Fig. 11. Spores of *L. antrophila,* magnified 1200 times.

Fig. 12. *Calicium kylemoriense.* Three of the apothecia, of natural size.

Fig. 13. An apothecium of the same, enlarged.

Fig. 14. Spores of this lichen, magnified 1200 times.

Fig. 15. *Verrucaria Larbalestierii.* Enlarged view of the thallus, to show its structure and the position of the apothecium.

Fig. 16. Vertical section of the apothecium, also enlarged.

Fig. 17. Spores of the same lichen, magnified 1200 times.

W.A.Leighton del

D.Blair lith.

M&N Hanhart imp.

NEW IRISH LICHENS

XVII. *Report on the Liliaceæ, Iridaceæ, Hypoxidaceæ, and Hæmodoraceæ of Welwitsch's Angolan Herbarium.* *By* J. G. Baker, Esq., *F.L.S.*

(Plates XXXIV.–XXXVI.)

Read March 1st, 1877.

THE present paper is devoted to a systematic account of the Liliaceæ, Iridaceæ, Hypoxidaceæ, and Hæmodoraceæ of the Angolan herbarium of the late Dr. Welwitsch. As will be seen, a very large proportion of the species are new to science. In the Liliaceæ there are two new genera, represented by five species; but the remaining novelties all belong to generic types already known either in Central Africa or at the Cape. The previously known flora of Central Africa in these orders is poor in numbers, and does not possess any strongly marked individuality of character. Its members, with few exceptions, belong either to the great cosmopolitan or great widely spread exclusively Old-World genera, like *Ornithogalum*, *Scilla*, *Urginea*, *Chlorophytum*, *Asparagus*, *Dracæna*, and *Gladiolus*, or are out-wandering representatives of the well-known characteristic Cape types, such as *Aloë*, *Kniphofia*, *Eriospermum*, *Albuca*, *Moræa*, *Anomatheca*, *Geissorhiza*, *Aristea*, and *Lapeyrousia*. Three well-known genera which attain their maximum in Central Africa are *Dracæna*, *Sanseviera*, and *Gloriosa*. *Walleria*, with two species, is the only previously known endemic Central-African genus. Dr. Welwitsch's collection, though it will more than double the number of species known in Central Africa, does not materially alter these general characters. In Liliaceæ it adds the two new endemic genera to which I have just referred; it carries within the tropic four Cape genera not previously known as intertropical—*Sandersonia*, *Tulbaghia*, *Schizobasis*, and *Haworthia*—and plants in more firmly *Aloë* and *Eriospermum* as intertropical genera. In the other orders all the genera represented are known in Central Africa already. I need scarcely add my tribute of appreciation of the excellence of Dr. Welwitsch's specimens, and of the pains which he must have taken in selecting them to show all the various stages and characters of the plants as fully and clearly as possible, or explain that in drawing up these descriptions I have been in many cases greatly indebted to the notes which he made upon the plants at the time when they were gathered. In my 'Systema' I have already indicated the position in the sequence of species of the Iridaceæ of this collection. In the present paper I have done this for the Liliaceæ by means of the numbers prefixed to the names, which refer to my monographs already published in the Journal of the Linnean Society. My best thanks are due to the executors of the late Dr. Welwitsch for the facilities they have given me in consulting the specimens and notes, which latter have been separated and copied for the British Museum, and upon both of which this paper is founded.

Order LILIACEÆ.

KNIPHOFIA, Mœnch. (Journ. Linn. Soc. xi. 360.)

K. BENGUELLENSIS, Welw. Herb. Herba 3–5-pedalis, rhizomate verticali lignoso, fibris copiosis cylindricis. Folia 3–4-pedalia, linearia, basi 6–9 lin. lata, a basi ad apicem attenuata, acuminata. Scapus 2–3-pedalis. Racemus subspicatus densus semipedalis vel pedalis, expansus 8–9 lin. crassus. Pedicelli brevissimi vel subnulli. Bracteæ deltoideæ membranaceæ, perianthio triplo breviores. Perianthium luteum campanulatum 2½ lin. longum, segmentis oblongis tubo æquilongis. Stamina demum exserta, antheris oblongis ½ lin. longis. Capsula globosa brunnea rugosa 2½ lin. longa, seminibus brunneis lucidis. *Huilla in palustribus juxta rivulos, socialis cum* Richardia angolensi *et* Epilobio æthiopico. Floret Dec.–Jan.

K. ANDONGENSIS, Baker. Herba gigantea, rhizomate incrassato, fibris radicalibus carnosis pedalibus vel sesquipedalibus. Folia linearia 6–9-pedalia, basi 8–9 lin. lata, ad apicem sensim angustata. Scapus foliis æquilongus, basi 1 poll. crassus. Racemus densus, inexpansus semipedalis. Pedicelli brevissimi. Bracteæ lanceolatæ 2 lin. longæ. Perianthium rubellum oblongum 3 lin. longum, segmentis oblongis tubo turbinato æquilongis. Flores perfecte expansos non vidi. *Pungo Andongo in dumetis petrosis alte graminosis inter Luxillo et Cotete.* Floret Maio. "Pongo" incolarum. Species angolenses ab reliquis notis recedunt perianthio profunde lobato.

TULBAGHIA, Linn. (Journ. Linn. Soc. xi. 369.)

1*. T. ÆQUINOCTIALIS, Welw. Herb. Bulbus ovoideus 6–9 lin. crassus, tunicis brunneis membranaceis. Folia 3–5 anguste linearia glabra subglaucescentia erecta 4–6 poll. longa, vix 1 lin. lata. Scapus gracilis folia superans. Umbella 3-flora, spathæ valvis 2 lanceolatis 3–4 lin. longis, pedicellis horizontalibus vel cernuis 3–4 lin. longis. Perianthium album 5 lin. longum, segmentis lanceolatis tubo æquilongis. Corona minutissima flava profunde lobata. *Pungo Andongo, in dumetis humidiusculis.* Floret Martio.

DIPCADI, Medic. (Journ. Linn. Soc. xi. 395.)

10*. D. OXYLOBUM, Welw. Herb. Bulbus subglobosus 6–9 lin. crassus, tunicis membranaceis albidis. Folia 2 suberecta subulata glabra facie canaliculata 4–6 poll. longa ½ lin. lata. Scapus gracilis flexuosus 6–9-pollicaris. Racemus laxus secundus 2–3-pollicaris 5–10-florus. Pedicelli 1–2 lin. longi. Bracteæ lanceolato-deltoideæ cuspidatæ viridulæ 2–3 lin. longæ. Perianthium viridulum cinnamomeo-rubens, segmentis interioribus 5 lin. longis, exterioribus 7–8 lin longis apice caudatis. *Pungo Andongo in declivis breviter herbidis rupium ipsius Præsidii, regio temp.* (2400–3800 pedes). Floret Nov.

14. D. WELWITSCHII, Baker in Journ. Linn. Soc. xi. 400. Racemus secundus laxe 6–15-

florus. Capsula globoso-quadrangulata 4 lin. longa. *Huilla, regio temperata, in dumetis herbidis prope Lopollo.* Floret Nov.–Dec.

17*. D. LATERITIUM, Welw. Herb. Bulbus globosus 9–12 lin. crassus, tunicis membranaceis albidis. Folia 2–4 linearia carnoso-herbacea erecta glabra ad apicem attenuata, pedalia vel sesquipedalia, 5–6 lin. lata. Scapus fragilis gracilis pedalis vel sesquipedalis. Racemus laxus secundus 2–6-pollicaris. Pedicelli ascendentes, inferiores demum 6–9 lin. longi. Bracteæ lineares acuminatæ 3–6 lin. longæ. Perianthium lateritium, segmentis interioribus 4–4½ lin. longis, exterioribus semipollicaribus apice distincte caudatis. Capsula sessilis 1½ lin. longa. *Huilla, regio temperata, in rupestribus editis Marro de Monimo ditionis Lopollo.* Floret Martio.

18*. DIPCADI COMOSUM, Welw. Herb. (Plate XXXIV. figs. 1–3.) Bulbus depresso-globosus, tunicis læte incarnatis, basi bulbillis stipatus. Folia linearia carnoso-herbacea glabra erecta bipedalia, basi 5–6 lin. lata, ad apicem attenuata, facie canaliculata. Scapus 3–4-pedalis, raro 5-pedalis. Racemus 1½–2-pedalis laxe 30–60-florus, pedicellis inferioribus 3–4 lin. longis, floribus viridibus, inferioribus perfectis 8–9 lin. longis, caudis brevibus, centralibus segmentis interioribus 3–4 lin. longis, exterioribus longe caudatis, floribus superioribus more *Muscari* parvis abortivis. Bracteæ superiores lineares acuminatæ 3–4 lin. longæ. *Huilla in arenosis dumetosis siccioribus inter Lopollo et Catumba.* Floret Aprili.

URGINEA, Steinh. (Journ. Linn. Soc. xiii. 215.)

14*. U. (SQUILLA) PSILOSTACHYA, Welw. Herb. Bulbus magnitudine pugni, apice hypogæo, tunicis multis albidis coriaceis. Folia post scapum perfecta 5–6 subcoriacea lorata glabra pedalia vel sesquipedalia 12–14 lin. lata. Scapus 2–3-pedalis. Racemus laxus sesquipedalis, expansus 1 poll. latus, pedicellis suberectis vel cernuis 3–4 lin. longis. Bracteæ minutæ lineares supra basin calcaratæ. Perianthium albidum 2½ lin. longum, segmentis late viridi vittatis. Stamina perianthio æquilonga, filamentis subulatis, antheris oblongis flavis ½ lin. longis. Stylus cylindricus exsertus. Capsula globoso-trigona 4 lin. longa. *Cazengo in dumetis siccis arenosis.* Floret Aug.

20*. U. (ALBUCOPSIS) COMOSA, Welw. Herb. Bulbus magnus globosus, tunicis membranaceis. Folia 6–8 carnoso-herbacea lineari-lorata erecta glauca 2–3-pedalia, basi 9–12 lin. lata, facie canaliculata, ad apicem attenuata. Scapus tripedalis et ultra. Racemus pedalis vel sesquipedalis, expansus 2–2½ poll. crassus, rachi stricta incrassata rugosa. Bracteæ subulatæ 6–9 lin. longæ ante anthesin comosæ. Pedicelli inferiores 6–9 lin. longi. Perianthium albidum 4–5 lin. longum, segmentis lanceolatis viridi-vittatis 5-nervatis. Filamenta perianthio paulo breviora, antheris flavis oblongis 1 lin. longis. Capsula 9 lin. longa profunde 3-lobata, seminibus multis discoideis nigris nitidis 4 lin. latis. *Mossamedes et Huilla, in pascuis sylvaticis humidiusculis inter Lopollo et Monino.* Floret Dec.–Jan.

30*. URGINEA (ALBUCOPSIS) CHLORANTHA, Welw. Herb. Bulbus globosus 1½ poll. crassus tunicis membranaceis. Folia 6–8 carnoso-herbacea lorata glabra bipedalia basi 1 poll. lata ad apicem acutum attenuata. Scapus elongatus. Racemus florifer semipedalis, fructifer sesquipedalis 1½ poll. latus. Bracteæ subulatæ 6–9 lin. longæ ante anthesin comosæ, haud calcaratæ. Pedicelli 4–6 lin. longi. Perianthium albidum 4½ lin. longum, segmentis lanceolatis viridi vittatis dorso distincte 5-nervatis. Filamenta linearia perianthio paulo breviora, antheris oblongis 1 lin. longis. Stylus ovario æquilongus. Capsula depresso-globosa 9 lin. lata profunde lobata, seminibus in loculo multis discoideis nigris nitidis 4 lin. latis. *Loanda, Pungo Andongo et Golungo Alto, in declivis olim cultis.* Floret Jan.–April.

ORNITHOGALUM, Linn. (Journ. Linn. Soc. xiii. 257.)

37*. O. (BERYLLIS) BENGUELLENSE, Baker. Bulbus ovoideus 6–9 lin. crassus, tunicis membranaceis brunneis apice haud setiferis. Folia 2–3 subteretia carnoso-herbacea glabra erecta semipedalia 1 lin. crassa. Scapus gracilis 6–9-pollicaris. Racemus laxus lanceolatus subsecundus 3–4-pollicaris. Pedicelli ascendentes, inferiores 3–4 lin. longi. Bracteæ minutæ deltoideæ, inferiores calcaratæ. Perianthium 2 lin. longum, segmentis albis purpureo vittatis. Stamina perianthio paulo breviora, antheris conformibus linearibus. Capsula immatura oblonga. *Huilla, regio temperata, in dumetis arenosis ad Lopollo.* Floret Nov.

46*. O. (BERYLLIS) CEPÆFOLIUM, Baker. Bulbus globosus tunicatus 1½–2 poll. crassus. Folia 4–5 lanceolata glabra acuminata pedalia vel sesquipedalia, basi 1–1½ poll. lata, facie canaliculata. Scapus bipedalis. Racemus densus 2–3-pollicaris, bracteis inferioribus multis haud floriferis. Bracteæ lineares 5–6 lin. longæ haud calcaratæ, ante anthesin comosæ. Pedicelli 2–3 lin. longi. Perianthium campanulatum 3 lin. longum, segmentis albis dorso viridi vittatis multinervatis. Filamenta conformia lanceolata 2 lin. longa, antheris oblongis 1 lin. longis. Capsula globosa 4 lin. longa, seminibus in loculo 6–8 compressis dimidiato-oblongis nigris. *Pungo Andongo et Huilla, in apricis herbidis prope Lopollo.* Floret Dec.

SCILLA, Linn. (Journ. Linn. Soc. xiii. 228.)

13*. S. (EUSCILLA) HISPIDULA, Baker. Bulbus oblongus 2–3 poll. crassus basi durus, tunicis densis crassis coriaceis. Folia 5–6 lanceolata rigida dura coriacea glabra 4–6 poll. longa, basi 1 poll. lata, nervis crebris exsculptis. Scapus 4–6-pollicaris cylindricus sursum pilosus. Racemus densus, expansus 4–8 poll. longus, 1 poll. crassus, rachi incrassata rugosa dense pilosa. Pedicelli patentes 3–4 lin. longi. Bracteæ lineari-subulatæ, pedicellis æquilongæ. Perianthium campanulatum albidum 1½ lin. longum. Stamina inclusa conformia. Stylus exsertus. Capsula sessilis, globosa, profunde lobata, 2 lin. longa, seminibus in loculo binis erectis.—*Huilla, in dumetis apricis arenoso-argillaceis prope Lopollo.* Floret Nov.

40*. SCILLA (LEDEBOURIA) BENGUELLENSIS, Baker. Bulbus globosus 1–2 poll. crassus, tunicis brunneis. Folia 2–6 sessilia synanthia linearia suberecta 4 lin. longa medio 3–4 lin. lata ad basin et apicem attenuata. Scapus flexuosus 2–3-pollicaris. Racemus densus oblongus 12–18 lin. longus, floribus inferioribus cernuis, pedicellis 2–3 lin. longis, bracteis minutis deltoideis. Perianthium campanulatum 1½ lin. longum, segmentis rubro-purpureis late viridi vittatis. Capsula sessilis globosa. *Huilla in pascuis apricis subarenosis prope Lopollo.* Floret Nov.

40*. S. (LEDEBOURIA) POLYPHYLLA, Baker. Bulbus globosus, 1 poll. crassus, tunicis brunneis. Folia 10–12 synanthia erecta subteretia glabra 3 poll. longa vix 1 lin. crassa. Scapus foliis æquilongus. Racemus laxus pauciflorus 5–6 lin. longus. Pedicelli perianthio æquilongi. Bracteæ minutæ deltoideæ. Perianthium campanulatum intense rubro-purpureum 1½ lin. longum, segmentis oblanceolatis infra medium reflexis. Stamina perianthio æquilonga. *Pungo Andongo et Golungo Alto in declivis rupestribus.* Floret Julio. Habitus *Scillæ autumnalis.*

40*. S. (LEDEBOURIA) ARENARIA, Baker. Bulbus ovoideus 6–9 lin. crassus, tunicis brunneis membranaceis. Folia 3–6 synanthia linearia erecta carnoso-herbacea glauco-viridia obscure petiolata 2 poll. longa 1½ lin. lata ad apicem sensim angustata. Scapus tripollicaris erectus gracilis. Racemus laxus oblongus, expansus 9–12 lin. longus, 5–6 lin. latus, pedicellis 1½–2 lin. longis, inferioribus cernuis, bracteis minutis deltoideis. Perianthium campanulatum purpureum 1 lin. longum, segmentis infra medium falcatis. Filamenta perianthio æquilonga saturate purpurea. Capsula globosa stipitata. *Pungo Andongo in pascuis arenosis sylvaticis.* Floret Martio.

47*. S. (LEDEBOURIA) SIMIARUM, Baker. Bulbus ovoideus 9–12 lin. crassus, tunicis brunneis membranaceis. Folia 3–4 synanthia carnoso-herbacea lanceolata glauco-viridia patula basi purpureo maculata 3–4 poll. longa, supra basin 5–6 lin. lata, acuta, haud petiolata. Scapus 2–3-pollicaris. Racemus oblongus sublaxus, florifer expansus 12–15 lin. longus, pedicellis 1½–2 lin. longis plerisque cernuis, bracteis minutis deltoideis. Perianthium viridulum purpureo tinctum campanulatum 1 lin. longum. Filamenta cyanea perianthio demum æquilonga. Capsula sessilis globosa. *Pungo Andongo et Loanda in sabulosis æstate inundatis.* Floret Aprili. "Bulbi simiis gratissimum pabulum."

47*. S. (LEDEBOURIA) FLACCIDULA, Baker. Bulbus globosus 8–9 lin. crassus, tunicis brunneis membranaceis. Folia 2–4 synanthia flaccida lorata carnoso-herbacea glabra 6–12 poll. longa 4–8 lin. lata acuta sessilia. Scapus debilis foliis æquilongus. Racemus laxus oblongus, fructifer 3–4 poll. longus, 6–8 lin. latus, pedicellis centralibus 2–3 lin. longis, bracteis minutis deltoideis. Perianthium campanulatum viridulum 1¼–1½ lin. longum,—segmentis infra medium falcatis. Stamina perian-

thio æquilonga. Stylus exsertus. Capsula sessilis globosa. *Pungo Andongo in rupestribus ipsius Præsidii.* Floret Nov.

47*. SCILLA (LEDEBOURIA) LAXIFLORA, Baker. Bulbus globosus 12–15 lin. crassus, tunicis brunneis membranaceis. Folia 3–4 synanthia carnoso-herbacea oblanceolata 4–5 poll. longa, supra medium 5–6 lin. lata, acuta, ad basin angustata. Scapus foliis æquilongus. Racemus cylindricus laxissimus 4–5-pollicaris, pedicellis centralibus patentibus 3–4 lin. longis, inferioribus cernuis, bracteis minutis deltoideis. Perithium viridulum campanulatum 1 lin. longum,—segmentis infra medium falcatis. Stamina perianthio æquilonga. Ovarium sessile, stylo exserto. *Loanda in collinis breviter graminosis.* Floret Maio.

48*. S. (LEDEBOURIA) CONGESTA, Baker. Bulbus globosus $1\frac{1}{2}$–2 poll. crassus, tunicis brunneis membranaceis. Folia 3 synanthia carnoso-herbacea lanceolata sessilia acuta 3–6 poll. longa, prope basin 12–15 lin. lata. Scapus 3–4-pollicaris. Racemus densus subspicatus, florifer 2 poll. longus, pedicellis infimis 1 lin. longis, bracteis minutis deltoideis. Perianthium campanulatum viridulum $2\frac{1}{2}$ lin. longum. Genitalia inclusa. Ovarium sessile. *Huilla in collinis dumetosis agri Lopollensis.* Floret Jan.

48*. S. (LEDEBOURIA) PLATYPHYLLA, Baker. Bulbus magnus ovoideo-globosus. Folia 4 synanthia carnoso-herbacea glabra oblonga acuta semipedalia, medio 15–18 lin., basi 1 poll. lata. Scapus semipedalis. Racemus densus $1\frac{1}{2}$–2 poll. longus, pedicellis omnibus ascendentibus $1\frac{1}{2}$–2 lin. longis, bracteis minutis deltoideis. Perianthium viridulum campanulatum 2 lin. longum. *Huilla, regio temperata, in dumetosis collinis parce graminosis inter Lopollo et Catumba.* Floret Dec.

57. S. (LEDEBOURIA) LANCEÆFOLIA, Baker in Saund. Ref. Bot. t. 182. Species capensis late disseminata. *Lopollo in collinis et Huilla in pascuis arenosis sylvaticis prope Mompulla, regio temperata.* Floret Oct.

ALBUCA, Linn. (Journ. Linn. Soc. xiii. 285.)

7*. A (FALCONERA) MYOGALOIDES, Welw. Herb. Bulbus ovoideus 1 poll. crassus, tunicis apice in setas dissolutis. Folia 3–4 synanthia glabra carnoso–herbacea erecta anguste linearia 1–2-pedalia, 3–4 lin. lata. Scapus pedalis, vel sequipedalis. Racemus laxus 6–12-florus semipedalis vel pedalis, pedicellis ascendentibus inferioribus 2–3 poll. longis, floribus erectis, bracteis lanceolatis inferioribus 6–9 lin. longis. Perianthium album 6–7 lin. longum, segmentis 2 lin. latis dorso viridi vittatis. Filamenta exteriora antheris parvis instructa. Stylus prismaticus ovario æquilongus. Capsula oblonga perianthio æquilonga. *Huilla in rupestribus editis Morro de Monino.* Floret Aprili. Ad *A. caudatam* capensem arcte accedit.

10*. ALBUCA (FALCONERA) MONOPHYLLA, Baker. *A. juncifolia*, Welw. Herb., non Baker in Gard. Chron. 1876, 534. Bulbus globosus 6–9 lin. crassus, tunicis teneris membranaceis apice haud setiferis. Folia solitaria raro bina teretia carnoso-herbacea glabra pedalia vix 1 lin. crassa glauco-viridia basi canaliculata. Scapus 4–8-pollicaris. Racemus laxe 2–6-florus, pedicellis erectis 3–4 lin. longis, floribus subnutantibus, bracteis lanceolatis cuspidatis 3–4 lin. longis. Perianthium 4½–5 lin. longum luteum, segmentis late viridi vittatis, exterioribus 1½ lin. latis. Filamenta omnia fertilia, antheris parvis oblongis luteis. Stylus prismaticus ovario æquilongus. *Pungo Andongo in rupestribus editis Præsidii Pedra de Cabonda.* Floret Aprili.

14*. A. (PALLASTEMA) SUBSPICATA, Baker. Bulbus globosus 6–9 lin. crassus, tunicis membranaceis apice haud setiferis. Folia 3–4 synanthia subulata carnoso-herbacea pedalia ad apicem attenuata. Scapus flexuosus 4–6-pollicaris. Racemus angustus 2–4-pollicaris, 4–12-florus, pedicellis adscendentibus 1½–3 lin. longis, floribus erectis vel patulis, bracteis lanceolatis longe cuspidatis inferioribus 6–9 lin. longis. Perianthium album 6 lin. longum, segmentis viridi vittatis 2 lin. latis. Filamenta omnia fertilia perianthio paulo breviora. Stylus gracilis ovario æquilongus. *Huilla ad rupes editas de Morro de Mino.*

14* A. (PALLASTEMA) GALEATA, Welw. Herb. Bulbus ovoideus, tunicis brunneis membranaceis. Folia synanthia glabra carnoso-herbacea flaccida viridia bipedalia 3–4 lin. lata, facie canaliculata. Scapus 1–2-pedalis. Racemus laxus 3–5-pollicaris, expansus 1½–2 poll. latus, pedicellis erecto-patentibus, infimis 5–6 lin. longis, floribus superioribus patulis, inferioribus cernuis, bracteis lanceolatis cuspidatis 3–6 lin. longis. Perianthium albidum subbilabiatum 7–7½ lin. longum, segmentis late viridi vittatis, tribus inferioribus declinatis, suprema galeata. Stamina omnia fertilia, antheris oblongis 1½ lin. longis. Stylus filiformis ovarium superans. *In dumetis petrosis prope Giucanda.* Floret Sept. "Dispositio laciniarum perigonii singularis quasi corollam bilabiatam fingens. Lacinia interna suprema galeam mentiens, in concavitate stamina 3 lacinia arcte adpressa gerentem." Welw. Herb.

15. A. ANGOLENSIS, Welw.; Baker in Saund. Ref. Bot. t. 336. *Huilla in pratis altis herbidis inter Lopollo et rivulo ejusdem nominis sporadica.* Floret Dec.–Feb.

15*. A. (PALLASTEMA) CHLORANTHA, Welw. Herb. Bulbus globosus 1½ poll. crassus, tunicis membranaceis apice haud setiferis. Flora plura synanthia lorata carnoso-herbacea glabra acuminata 1½–2-pedalia, basi 1½ poll. lata. Scapus elongatus. Racemus subdensus pedalis, expansus 2 poll. latus, pedicellis 1½–2 lin. longis, bracteis lanceolatis acuminatis 1½–2 poll. longis, floribus inferioribus horizontalibus, supremis ascendentibus subsessilibus. Perianthium flavum 9–12 lin. longum, segmentis dorso late viridibus 2–3 lin. latis. Filamenta omnia fertilia, antheris oblongis 2 lin.

longis. Stylus filiformis 5–6 lin. longus, ovario æquilongus. *Pungo Andongo in dumetis ad ripas fluminis Juanza.* Floret Martio.

DRACÆNA, Vand. (Journ. Linn. Soc. xiv. 523.)

11*. D. PARVIFLORA, Baker. Arbor 20–35-pedalis dichotome ramosa, ramis erecto-patulis. Folia dense rosulata sessilia lanceolata subcoriacea 3–4-pedalia, medio 3 poll., supra basin 1 poll. lata, costa præter apicem perspicua, marginibus concoloribus. Panicula pedalis et ultra, floribus densis, ad apices ramorum 20–30 congestis, bracteis perminutis deltoideis, pedicellis 2 lin. longis. Perianthium albidum 4–4½ lin. longum, segmentis tubo æquilongis. Stylus exsertus. *Golungo Alto ad rivulos in editioribus sylvaticis.* Floret Feb. "*Die calunga*" incolarum.

15. D. FRAGRANS, Gawl. in Bot. Mag. t. 1081. *Pungo Andongo.*

19*. D. NITENS, Welw. Herb. Arbuscula 7–10-pedalis. Folia linearia laxe disposita subpatula subcoriacea viridia lucida 6–10 poll. longa, 4½–6 lin. lata, sessilia acuta, costa præter apicem perspicua, marginibus concoloribus. Pedunculus brevissimus. Panicula semipedalis vel pedalis, ramis pluribus brevibus patulis, pedicellis brevissimis, bracteis minutis deltoideis. Perianthium cylindricum albidum rubro tinctum, segmentis ligulatis tubo brevioribus. Stylus exsertus. *Golungo Alto et Pungo Andongo in montosis rupestribus.* Floret Sept.

25*. D. ACAULIS, Baker. Acaulis, rhizomate lignoso ½–1 poll. crasso. Folia omnia in rosulam basalem congesta lanceolata acuta firma 3–6-pedalia medio 2 poll. lata, in petiolum pedalem alatum sensim angustata. Panicula pedunculata 4–5-pedalis, ramis multis flexuosis ascendentibus racemosis, bracteis inferioribus semipedalibus. Pedicelli brevissimi aggregati. Perianthium albidum 14–15 lin. longum, segmentis tubo paullo longioribus. Stamina segmentis æquilonga, antheris oblongis 1½ lin. longis. Stylus demum exsertus. *Golungo Alto, regio* 2 (1000–2400 *pedes*) *in sylvaticis editioribus et ad rivulorum latera montium de Alta Queta.* Floret Julio.

33*. D. MONOSTACHYA, Baker. Acaulis. Folia omnia in rosulam basalem congesta oblongo-lanceolata acuta semipedalia vel pedalia, infra medium 1½–2 poll. lata, ad basin cuneatam rotundata, petiolo pedali instructa. Pedunculus pedalis, bracteis multis parvis lanceolatis præditus. Racemus simplex densus erectus 2–3-pollicaris, pedicellis brevissimis fasciculatis, bracteis minutis deltoideis. Perianthium non vidi. Bacca profunde lobata. *Insula Principis in herbidis subhumidis sylvarum non procul oceano.* Sept. (in fructu); et planta affinis Angolensis in ditione *Golungo Alto* adest foliis magis oblongis 6–8 poll. longis, 2–2½ poll. latis basi magis rotundatis, pedunculo breviore et racemo laxiore.

38*. D. INTERRUPTA, Baker. Arbuscula subscandens 3–4-pedalis, ramis virgatis cylindricis gracilibus. Folia in rosulas segregatas disposita oblongo-oblanceolata cuspi-

data 4–5 poll. longa, medio 2–2½ poll. lata, basi cuneata in petiolum brevem 1½ lin. latum angustata, costa præter apicem perspicua. Racemus simplex breviter pedunculatus 4–5-pollicaris, floribus dense fasciculatis, pedicellis 1½ lin. longis supra medium articulatis, bracteis membranaceis deltoideis vel lanceolatis 2–3 lin. longis. Flores odorati albi. Perianthium cylindricum 9–11 lin. longum, segmentis tubo subduplo brevioribus. Filamenta segmentis paullo breviora, antheris 1 lin. longis. Stylus demum exsertus. *Pungo Andongo, in sylvis ad marginem fluminis Tombe.* Floret Martio.

SANSEVIERA, Thunb. (Journ. Linn. Soc. xiv. 546.)

3*. S. BRACTEATA, Baker. Folia rigidissima coriacea lanceolata albo maculata rubro marginata 1–2-pedalia, medio 2–2½ poll. lata, basi in petiolum latum elongatum angustata. Pedunculus crassus strictus sesquipedalis vel pedalis, foliis multis reductis lanceolatis, inferioribus 3–4 poll. longis, præditus. Racemus simplex densus semipedalis, bracteis lanceolatis membranaceis 9–12 lin. longis, pedicellis brevissimis fasciculatis. Perianthium album 2½–3 poll. longum, segmentis ligulatis 8–9 lin. longis. Stamina inclusa, antheris oblongis 1½ lin. longis. *Pungo Andongo, in rupestribus subsiccis editioribus.* Floret Jan. Ad *S. longifloram* arcte accedens.

ASPARAGUS, Linn. (Journ. Linn. Soc. xiv. 594.)

28*. A. EQUISETOIDES, Welw. Herb. Frutex ramosissimus, ramis erecto-patentibus pinnatis, ramulis gracilibus erecto-patentibus pedalibus vel semipedalibus, internodiis ultimis 2–3 lin. longis. Folia ramorum basi calcari parvo deltoideo instructa. Cladodia ad nodos sæpissime nulla, raro producta solitaria subulata 2–3 lin. longa ad ramos adpressa. Flores non vidi. *Pungo Andongo, in arenosis ad ripas fluminis Cuenza.*

38*. A. BENGUELLENSIS, Baker. Arbuscula decumbens glabra subscandens, ramis gracilibus copiose pinnatis, ramulis adscendentibus vel patulis 4–6 poll. longis, internodiis ultimis 2–3 lin. longis. Folia inferiora lanceolata, obscure calcarata. Cladodia 3–6na subulata ascendentia 6–9 lin. longa. Pedicelli 1–2ni, raro 3–4ni, 4–5 lin. longi, medio articulati. Perianthium infundibulare 3 lin. longum, segmentis oblongo-spathulatis diu ascendentibus brunneo vittatis. Antheræ minutæ oblongæ, filamento triplo breviores. *Mossamedes et Huilla, in dumetis sylvestribus ad Mumpullo.* Floret Julio.

38*. A. PSILURUS, Welw. Herb. Herba erecta, 2–3-pedalis, habitu *A. officinalis*, ramis et ramulis copiosis gracillimis erecto-patentibus, ultimis pedalibus vel semipedalibus. Folia ramorum calcari obscuro deltoideo deflexo instructa. Cladodia 6–8na, subulata erecto-patenta 4–9 lin. longa. Pedicelli cernui solitarii 2–3 lin. longi medio

articulati ad nodos efoliatos sæpe producti. Perianthium infundibulare 1½–2 lin. longum, segmentis albis brunneo vittatis diu ascendentibus. Antheræ minutæ oblongæ, filamento triplo breviores. *Pungo Andongo, in dumetis Cuazensibus, frequens.* Floret Maio.

53*. ASPARAGUS DEFLEXUS, Baker. Frutex ramosissimus, glaber, ramis gracilibus, inferioribus deflexis, ramulis multis brevibus sæpe internodio unico solum præditis, internodiis ultimis 1–1½ lin. longis. Folia ramorum calcari parvo deflexo pungente instructa. Cladodia subulata 6–10na 3–4 lin. longa. Pedicelli 1½–2 lin. longi, medio articulati, ad nodos laterales 1–2ni, ad nodos terminales sæpe 4–6ni. Perianthium 1½ lin. longum, segmentis oblongo-spathulatis brunneo vittatis. Stamina perianthio distincte breviora, antheris minutis oblongis. *Pungo Andongo.* Floret Oct.

53*. A. PUBESCENS, Baker. Frutex ramosissimus pubescens, ramulis arcuato-ascendentibus semipedalibus vel pedalibus, internodiis ultimis 1½–2 lin. longis. Folia ramorum basi calcari deltoideo parvo pungente instructa. Cladodia 4–8na, subulata, erecto-patentia glabra 2–3 lin. longa. Pedicelli 1–2ni erecto-patentes 1½–2 lin. longi, infra medium articulati, ad ramos vel nodos cladodiis nullis præditos sæpissime producti. Perianthium 1½ lin. longum. Antheræ minutæ oblongæ luteæ. Bacca magnitudine pisi parvi. *Huilla, regio temperata, in pascuis siccis ad Catumba.* Floret Dec.

72*. A. ANGOLENSIS, Baker. Frutex ramosissimus subscandens, habitu *A. africani*, ramis lignosis flexuosis puberulis, ramulis copiosis erecto-patentibus. Folia ramorum calcari subulato pungente deflexo 3–4 lin. longo instructa. Cladodia densissime fasciculata (20–50na) gracillima rigida subulata 6–9 lin. longa. Pedicelli patuli fasciculati 2 lin. longi prope basin articulati. Perianthium infundibulare 1½ lin. longum. Stamina perianthio æquilonga, antheris minutis globosis. Bacca magnitudine pisi parvi. *Huilla, reglo temperata.*

73. A. AFRICANUS, Lam. *Pungo Andongo, in sylvaticis.*

85. A. RACEMOSUS, Willd. *Loanda et Huilla, in dumetis.*

90*. A. DREPANOPHYLLUS, Welw. Herb. Frutex glaber, latissime volubilis, ramis gracilibus lignosis, internodiis ultimis 1½–2 lin. longis. Folia ramorum basi calcari pungente subulato 2 lin. longo prædita. Cladodia 3, inæqualia, linearia, falcata, rigidula acuta distincte costata, majora 9–12 lin., minora 2–3 lin. longa. Racemi sessiles, 3–6 poll. longi, 4½–5 lin. lati, pedicellis 3–6nis 1–1½ lin. longis, medio articulatis. Perianthium campanulatum 1 lin. longum, segmentis late viridi vittatis. Antheræ minutæ oblongæ inclusæ. *Golungo Alto, in sylvis densis sporadicus.* Floret Maio.

SCHIZOBASIS, Baker. (Journ. Linn. Soc. xvi. 260.)

S. ANGOLENSIS, Baker. *Adenotheca aphylla*, Welw. Herb. Bulbus globosus 1–1½ poll. crassus intus albidus viscosus, tunicis brunneis membranaceis. Folia hysteranthia non vidi. Scapus gracilis semipedalis. Panicula deltoidea pedalis, ramis gracilibus erecto-patentibus, inferioribus compositis, ramulis ultimis 4–5 poll. longis. Pedicelli remoti solitarii ascendentes 3–4 lin. longi prope apicem articulati. Bracteæ minutæ deltoideæ. Perianthium 2 lin. longum, segmentis oblongis brunneo vittatis. Stamina inclusa, filamentis leviter applanatis, antheris oblongis filamento brevioribus. *Pungo Andongo, ad rupes ipsius Præsidii, alt.* 2400–3800 *pedum.* Floret Aug.

ACROSPIRA, Welw. Herb. (Genus novum Asphodelearum.)

Perianthium album, diu infundibulare, basi brevissime urceolatum, segmentis æqualibus oblanceolatis, nervis 3–5 in carinam centralem concretis. *Stamina* 6 inclusa profunde perigyna, *filamentis* brevibus æqualibus lanceolatis, *antheris* magnis linearibus basifixis apice spiraliter revolutis. *Ovarium* parvum sessile ovoideum 3-loculare, ovulis in loculo circiter 20 horizontalibus biseriatis; *stylus* leviter exsertus filiformis leviter declinatus superne sensim robustior, *stigmate* parvo capitato penicillato. *Fructum* non vidi.

A. ASPHODELOIDES, Welw. Herb. (Plate XXXIV. figs. 4–7.) Rhizoma obliquum, crassum, fibris multis gracilibus præditum. Folia 5–6 sessilia subcoriacea lorata 2–3-pedalia deorsum 12–15 lin. lata ad apicem angustata glabra crebre distincte nervata. Pedunculus 4–6-pedalis, foliis pluribus reductis præditus. Racemus pedalis vel sesquipedalis simplex vel basi ramis 1–2 parvis instructus, pedicellis ascendentibus 3–4nis inæqualibus 1–3 lin. longis, bracteis deltoideis. Perianthium 9–10 lin. longum, segmentis 1 lin. latis. Antheræ luteæ 5–6 lin. longæ. Stylus 8–9 lin. longus. *Pungo Andongo, in rupestribus editioribus, frequens.* Floret Mart.–April.

DASYSTACHYS, Baker. (Genus novum Asphodelearum.)

Perianthium album diu campanulatum, segmentis æqualibus lanceolatis dorso 1-nervatis. *Stamina* inclusa æqualia, *filamentis* profunde perigynis elongatis leviter applanatis, *antheris* parvis oblongis versatilibus. *Ovarium* sessile globosum apice et lateribus profunde lobatis triloculare, *ovulis* in loculo paucis superpositis; *stylus* filiformis declinatus exsertus, stigmate capitato. *Capsula* globosa profunde lobata loculicide trivalvis, *seminibus* in loculo paucis discoideis. *Herbæ africanæ tropicales, habitu* Antherici, *rhizomate obliquo tuberoso, fibris multis gracilibus prædito, foliis basalibus rosulatis linearibus vel lanceolatis arundinaceis crebre nervatis, pedunculo foliis reductis vaginato, floribus parvis in racemos subspicatos sæpissime simplices dispositis.*

1. D. PLEIOSTACHYA, Baker. *Anthericum*? *pleiostachyum*, Welw. Herb. Rhizoma tuberosum 6–9 lin. crassum, fibris pluribus radicalibus præditum. Folia basalia 3–4 lanceolata subcoriacea glabra crebre nervata subpedalia 6–9 lin. lata. Scapus 2–3-pedalis, foliis multis reductis linearibus adpressis præditus. Racemi 1–3 densi

subspicati 6–9 poll. longi 5–6 lin. lati, pedicellis brevissimis vel subnullis, bracteis setaceis 5–6 lin. longis basi dilatatis. Perianthium album 3 lin. longum. Stamina perianthio æquilonga, antheris minutis oblongis. Capsula globosa 2½–3 lin. longa, lateribus profunde lobatis. *Pungo Andongo, in pratis graminosis ad ripas fluminis Cuenza.* Floret Aprili.

2. Dasystachys falcata, Baker. *Anthericum ? falcatum*, Welw. Herb. Rhizoma oblongum tuberosum horizontale, fibris gracilibus multis præditum. Folia basalia rosulata 6–8 lorata facie canaliculata basin caulis longe vaginantia superne falcata 6–9 poll. longa 10–12 lin. lata crebre distincte nervata margine crispata. Pedunculus rubellus sesquipedalis vel bipedalis, foliis multis reductis præditus. Racemus simplex subspicatus, floriferus 3–4 poll., fructiferus 6–8 poll. longus, 8–9 lin. latus, pedicellis brevissimis. Perianthium album 3 lin. longum. Stamina perianthio æquilonga. Capsula 4 lin. longa, seminibus in loculo 3–4 discoideis. *Huilla, regio temperata, in rupestribus Morro de Lopollo et Mossamedes, in sylvis inter Bumbo et Bruco.* Floret Oct.–Jan.

3. D. colubrina, Baker. (Plate XXXV. figs. 1–6.) *Anthericum ? colubrinum*, Welw. Herb. Rhizoma obliquum tuberosum, fibris radicalibus multis gracilibus præditum. Folia basalia exteriora rudimentaria rubro-purpureo maculata, interiora producta 5–6 linearia glabra subcoriacea pedalia, medio 3 lin. lata, ad apicem et basin angustata. Scapus simplex pedalis, foliis 2–3 reductis præditus. Recemus subspicatus simplex oblongus 1½–2 poll. longus, 8–9 lin. latus, pedicellis subnullis, bracteis purpureis deltoideis longe cuspidatis, infimis 3–4 lin. longis. Perianthium 3 lin. longum, segmentis rubro-purpureo vittatis. Stamina perianthio æquilonga. Stylus declinatus longe exsertus. Capsula globosa 3 lin. longa, lateribus profunde lobatis. *Huilla, in pascuis rupestribus herbidis de Empalanca, alt.* 5500 *pedum.* Floret Jan.

4. D. campanulata, Baker. (Plate XXXV. figs. 7–10.) *Campylandra dasystachys*, Welw. Herb. Rhizoma obliquum tuberosum, fibris multis radicalibus gracilibus præditum. Folia rosulata basalia producta 5–6 lanceolata basin caulis longe vaginantia pedalia vel sesquipedalia basi 1 poll. lata crebre distincte nervata ad apicem sensim angustata, marginibus minute ciliatis et crispatis. Pedunculus 3–4-pedalis, foliis multis reductis vaginatus. Racemus simplex densus subspicatus 3–6-pollicaris 8–9 lin. crassus, bracteis lanceolatis longe acuminatis, inferioribus 5–6 lin. longis. Perianthium 4 lin. longum. Stamina perianthio æquilonga. Stylus 4–4½ lin. longus longe exsertus. Capsula 4 lin. longa, lateribus acute angulatis. *Huilla, regio temperata, in pratis herbidis inter Lopollo et lacum Mantalla.* Floret Martio.

Anthericum, Linn. (Journ. Linn. Soc. xv. 290.)

27*. A. (Phalangium) tenellum, Welw. Herb. Dense cæspitosum, rhizomate apice dense setifero, fibris radicalibus cylindricis 1–2 poll. longis. Folia dense rosulata

anguste linearia erecta glabra 2–3 poll. longa, 1 lin. lata ad apicem angustata. Scapi multi gracillimi folia sæpe superantes. Racemi laxissimi 2–3 poll. longi simplices vel paniculati, bracteis minutis deltoideis, pedicellis 1½–3 lin. longis, inferioribus 2–3nis. Perianthium 3 lin. longum album membranaceum, segmentis anguste oblanceolatis, dorso laxe 3–4-nervatis. Stamina perianthio distincte breviora, antheris minutis oblongis, filamentis glabris. Stylus 1½ lin. longus inclusus ovario æquilongus. *Huilla, regio temperata, in pascuis humidiusculis subarenosis de Morro Monino.* Floret Dec.

27*. ANTHERICUM (PHALANGIUM) DISSITIFLORUM, Baker. Rhizoma parvum tuberosum, fibris radicalibus multis gracilibus præditum. Folia linearia glabra modice firma 3–5 poll. longa, 1½ lin. lata, facie canaliculata, nervis crebris distinctis 12–15. Scapus supra folia eminens acute anceps. Racemus simplex laxus 1–1½-pollicaris 3–6-florus, pedicellis solitariis 1½–3 lin. longis, medio articulatis, bracteis lanceolatis acuminatis 2–3 lin. longis. Perianthium 3–4 lin. longum, segmentis oblanceolatis dorso purpureo vittatis 5-nervatis. Stamina perianthio distincte breviora, antheris oblongis 1 lin. longis, filamentis linearibus glabris. Stylus 2 lin. longus. Capsula depresso-globosa 2 lin. longa. *Pungo Andongo, in pascuis humidis prope Condo.* Floret Martio.

27*. A. (PHALANGIUM) BENGUELLENSE, Baker. Cæspitosum, rhizomate setis densis coronato, fibris radicalibus gracilibus. Folia plura linearia glabra canaliculata 3–6 poll. longa 3–4 lin. lata 12–15-nervata minute ciliata. Scapus anceps nudus 3–9-pollicaris, erectus vel curvatus. Panicula deltoidea 3–4-pollicaris, floribus inferioribus 2–3nis, pedicellis 1–1½ lin. longis, bracteis deltoideis. Perianthium 4–4½ lin. longum, segmentis oblanceolatis dorso purpureo vittatis 3–5-nervatis. Stamina perianthio triente breviora, filamentis glabris, antheris parvis oblongis. *Huilla, regio temperata, in sylvis claris et pascuis dumosis circa Lopollo et Humpata.* Floret Jan.

27*. A. (PHALANGIUM) LIMOSUM, Baker. Rhizoma tuberosum, fibris radicalibus gracilibus, brevibus. Folia radicalia 5–6 linearia subfirma pedalia 5–6 lin. lata crebre nervata. Scapus 3–6-pollicaris. Panicula 3–4-pollicaris, ramis pluribus erecto-patentibus, pedicellis 1½–2 lin. longis medio articulatis, inferioribus fasciculatis. Perianthium 4–4½ lin. longum, segmentis lanceolatis purpureo vittatis dorso distincte 3–5-nervatis. Antheræ 2 lin. longæ, filamentis glabris. Stylus declinatus 2–2½ lin. longus. *Barra do Bengo, in inundatis limosis exsiccatis.*

27*. A. (PHALANGIUM) ANDONGENSE, Baker. Rhizoma obliquum tuberosum, fibris radicalibus filipendulis 2–3 poll. longis. Folia radicalia 4–6 anguste linearia glabra subcoriacea rigidula semipedalia 1–1½ lin. lata crebre nervata, marginibus minute ciliatis. Scapus simplex pedalis complanatus nudus. Racemus simplex laxus bipollicaris, pedicellis 3–4 lin. longis infra medium articulatis, inferioribus 2–3nis. Perianthium 4 lin. longum, segmentis purpureo vittatis dorso 3–4-nervatis. Stamina

perianthio subduplo breviora, antheris 1½ lin. longis, filamento glabro duplo longioribus. Capsula globosa 3 lin. longa, valvis profunde horizontaliter plicatis. *Pungo Andongo, in arenosis humidis sylvaticis inter Luxillo et Cazella.* Floret Jan.

27*. ANTHERICUM (PHALANGIUM) ORCHIDEUM, Welw. Herb. Rhizoma obliquum tuberosum, setis multis coronatum, fibris carnosis filipendulis. Folia radicalia 6–8 oblongo-lanceolata subcoriacea glabra crebre nervata 6–9 poll. longa, 12–15 lin. lata. Scapus 3–8-pollicaris. Racemus sæpissime simplex densus 3–4-pollicaris, pedicellis 3–6 lin. longis 3–6nis medio articulatis. Perianthium 4–4½ lin. longum, segmentis oblanceolatis dorso purpureo brunneo vittatis 7–9-nervatis. Stamina perianthio subduplo breviora, antheris oblongis filamento glabro æquilongis. Stylus declinatus 3 lin. longus. Capsula globosa 3 lin. longa, valvis horizontaliter plicatis. *Huilla, regio temperata, in graminosis humidiusculis ad basin Serra de Monino.* Floret Jan.

27*. A. (PHALANGIUM) USTULATUM, Welw. Herb. Rhizoma gracile late reptans. Folia 3 exteriora rudimentaria lanceolata firma nigro fasciata, 3 interiora producta stricta erecta teretia glabra 6–8 poll. longa, ⅓ lin. crassa. Scapus simplex semipedalis. Racemus laxus simplex 1–1½-pollicaris, pedicellis 2–3nis 1½–3 lin. longis, bracteis purpureis lanceolatis cuspidatis, infimis 3–4 lin. longis. Perianthium 4 lin. longum, segmentis purpureo-brunneo vittatis 4–5-nervatis. Stamina perianthio subduplo breviora, antheris oblongis filamento glabro æquilongis. *Huilla et Pungo Andongo, in spongiosis sylvaticis.* Floret Martio–Aprilem.

27*. A. (PHALANGIUM) CALYPTROCARPUM, Baker. Fibræ radicales cylindricæ flexuosæ, collo radicis dense setoso. Folia producta 1–2 teretia glabra pedalia et ultra vix 1 lin. crassa. Scapus semipedalis glaber gracilis. Panicula deltoidea 6–9-pollicaris, ramis pluribus ascendentibus, racemis laxissimis, internodiis infimis 12–18 lin. longis, pedicellis 2–3 lin. longis, inferioribus geminis, bracteis minutis deltoideis cuspidatis. Perianthium 3 lin. longum tenerum, basi circumscissum, segmentis dorso fusco vittatis. Stamina perianthio triente breviora, antheris oblongis filamento glabro æquilongis. Capsula turbinata, seminibus in loculo pluribus atris minutis triquetris. *Huilla, regio temperata, in pascuis petrosis tempore pluvii inundatis, inter Mumpulla et Lopollo.* Floret Dec.

33*. A. (PHALANGIUM) PTEROCAULON, Welw. Herb. Rhizoma tuberosum, fibris radicalibus gracilibus, apice setis paucis præditum. Folia 3–4 linearia subcoriacea basin caulis longe amplectentia 2–3-pedalia, 5–6 lin. lata, nervis crebris pilosis. Scapus anceps compressus 3–5-pedalis. Racemus simplex strictus 3–6-pollicaris, nodis inferioribus distantibus, pedicellis 3–4 lin. longis medio articulatis, inferioribus 2–3nis. Perianthium album 5–6 lin. longum, segmentis dorso anguste vittatis. Stamina perianthio subduplo breviora, antheris oblongis filamentis linearibus glabris æquilongis. Capsula subglobosa 3–4 lin. longa. *Pungo Andongo, in dumetis inter Calundo et Pedras de Guinza.* Floret Martio.

33*. ANTHERICUM (PHALANGIUM) ARENARIUM, Baker. Fibræ radicales cæspitosæ graciles semipedales filipendulæ, collo radicis dense setoso. Folia producta 3–4 lanceolata falcata rigida coriacea 5–6 poll. longa, e medio 3–9 lin. lato ad apicem et basin angustata, nervis 30–40 crebris dense pilosis. Scapus pedalis vel semipedalis subcompressus superne pilosus. Racemus densus simplex 1–2-pollicaris, bracteis pilosis lanceolatis 6–9 lin. longis, pedicellis 2–3nis medio articulatis, inferioribus 3–4 lin. longis. Perianthium album 4–4½ lin. longum, segmentis dorso multinervatis. Stamina perianthio subduplo breviora, antheris linearibus filamento glabro æquilongis. Capsula globosa 3 lin. longa. *Pungo Andongo, in dumetis arenosis inter Candumbe et Lombe.* Floret Martio.

A. DRIMIOPSIS, Baker (J. L. S. xv. 301). Planta zambesiaca a Kirkio lecta etiam ad genus pertinet.

50. A. (TRACHYANDRA) JACQUINIANUM, Schult. *Huilla, regio temperata, in pascuis et arenosis humidiusculis.* Floret Jan.–Feb.

Var. AFFINIS, Baker. *Pungo Andongo.*

54*. A. (TRACHYANDRA) PYRENICARPUM, Welw. Herb. Fibræ radicales graciles, collo radicis squamis parvis membranaceis cincto. Folia 6–8 anguste linearia parce pilosa linearia facie canaliculata 6–8 poll. longa 1 lin. lata. Scapi 2–4ni 2–3-pollicares subtiliter pilosi. Racemus laxus simplex 2–3-pollicaris, pedicellis 3–4 lin. longis, inferioribus cernuis, bracteis lineari-subulatis 3–4 lin. longis. Perianthium album 4 lin. longum, segmentis oblanceolatis. Stamina perianthio triente breviora, antheris minutis. Capsula glabra turbinata 3 lin. longa, seminibus in loculo solitariis. *Huilla, regio temperata, in pascuis humidis inter Humpata et Gambas.* Floret Jan.

69*. A. (DILANTHES) MOLLE, Baker. Fibræ radicales densæ, interdum apice filipendulæ oblongæ. Folia rosulata 20–30 petiolata; petiolus 1–3-pollicaris pilis lanosis patulis densis præditus; lamina lanceolata 2–3-pollicaris dense pilosa crebre nervata. Scapus semipedalis gracilis erectus. Racemus simplex vel furcatus densus 1–1½-pollicaris, bracteis pilosis lanceolatis acuminatis 3–6 lin. longis, pedicellis 2–3 lin. longis medio articulatis, inferioribus 2–3nis. Perianthium 3 lin. longum, segmentis albis lanceolatis dorso purpureo vittatis 5-nervatis. Antheræ 1½ lin. longæ, filamenta subulata muricata superantes. Stylus declinatus 2 lin. longus. Capsula globosa 2 lin. longa, valvis horizontaliter plicatis. *Pungo Andongo, in apricis petrosis totius Præsidii.* Floret Nov.–Dec.

CHLOROPHYTUM, Ker. (Journ. Linn. Soc. xv. 321.)

5. C. MACROPHYLLUM, Aschers. *C. leucolepis*, Welw. Herb. *Pungo Andongo, in rupium fissuris ad scaturigines et juxta rivulos Præsidii.* Floret Dec.

7*. CHLOROPHYTUM FILIPENDULUM, Baker. Rhizoma obliquum, fibris radicalibus filipendulis 2–4 poll. longis. Folia pauca petiolata; petiolus canaliculatus 1–4-pollicaris; lamina oblongo-lanceolata membranacea glabra 6–9 poll. longa, $1\frac{1}{2}$–2 poll. lata, supra viridis, infra pallida, acuta, basi cuneata, nervis perspicuis 20–25 prædita. Scapus semipedalis vel pedalis, nudus vel folio unico instructus. Racemus laxus semipedalis simplex vel raro furcatus, bracteis viridibus lanceolatis 4–6 lin. longis, pedicellis 2–3nis, inferioribus 3–4 lin. longis. Perianthium albo-viridulum 3–4 lin. longum, segmentis dorso distincte trinervatis. Stamina perianthio triente breviora, antheris 1 lin. longis, filamento subulato. Capsula oblonga 4 lin. longa, seminibus in loculo 6–8. *Golungo alto in umbrosis ad rivulos in montes de Queta.* Floret Dec.

8*. C. LANCIFOLIUM, Welw. Herb. Fibræ radicales graciles 3–4 poll. longæ. Folia rosulata 5–6; petiolus 5–6-pollicaris; lamina lanceolata vel oblongo-lanceolata glabra membranacea 3–4 poll. longa acuta, basi cuneata vel rotundata, venis perspicuis 12–15. Scapus 3–4-pollicaris. Racemus simplex laxissimus, floriferus expansus semipedalis, fructiferus pedalis, bracteis lanceolatis 3–4 lin. longis, pedicellis 3–4nis 1–$1\frac{1}{2}$ lin. longis supra medium articulatis. Perianthium albo-viridulum 2 lin. longum, segmentis linearibus. Capsula globosa 2 lin. longa, seminibus in loculo tribus. *Pungo Andongo, in umbrosis ad cataractas rupium ipsius Præsidii.* Floret Nov.

22*. C. DEBILE, Baker. Fibræ radicales 2 poll. longæ graciles vel incrassatæ. Folia radicalia plura petiolata; petiolus 1–3-pollicaris; lamina lanceolata membranacea glauco-viridis glabra 2–4 poll. longa 3–4 lin. lata e medio ad basin et apicem angustata, venis perspicuis 10–12 prædita. Scapi brevissimi 2–3ni. Racemus simplex laxissimus 2–6-pollicaris sæpe deflexus, internodiis inferioribus 9–12 lin. longis, bracteis lanceolatis viridibus cuspidatis 3–4 lin. longis, pedicelliis 1–2 lin. longis medio articulatis solitariis vel geminis. Perianthium albo-viridulum 2 lin. longum, segmentis linearibus. Capsula depresso-globosa 3 lin. longa. *Congo; Ambriz, ad rupes.* Floret Nov.

26*. C. ANDONGENSE, Baker. Fibræ radicales cylindricæ 3–4 poll. longæ. Folia radicalia 5–6 sessilia lorata suberecta glabra pedalia vel sesquipedalia medio 6–15 lin. lata chartacea, venis circiter 20, marginibus albidis. Scapus pedalis et ultra. Panicula deltoidea 1–2-pedalis, ramis erecto-patentibus, bracteis deltoideis cuspidatis 2–3 lin. longis, racemis laxis, pedicellis 3–6nis 6–9 lin. longis, medio articulatis. Perianthium albido-viridulum 6 lin. longum, segmentis oblanceolatis dorso 5–6-nervatis. Stamina perianthio paulo breviora, filâmentis subulatis. Capsula dura globosa 4–5 lin. longa, seminibus in loculo 3–4. *Pungo Andongo, in dumetis rupestribus omnibus Præsidii.* Floret Dec.

30. C. STENOPETALUM, Baker. *C. bracteosum*, Welw. Herb. *Huilla, in sylvis* Protearum *ad Lopollo.* Floret Dec.

Bulbine, Linn. (Journ. Linn. Soc. xv. 341.)

B. asphodeloides, Schult. fil. *Pungo Andongo et Huilla, regio temperata, in sylvis clarioribus subarenosis.* Floret Dec. = Liliacea, No. 14, Welw. Apont. p. 592.

Eriospermum, Jacq. (Journ. Linn. Soc. xv. 262.)

4*. E. stenophyllum, Welw. Herb. Tuber depresso-globosum sat magnum setis densis coronatum. Folia solitaria synanthia petiolata; petiolus 1–2-pollicaris; lamina linearis glabra subcoriacea erecta crebre nervata 6–8 poll. longa $2\frac{1}{2}$–3 lin. lata, a medio ad apicem et basin sensim attenuata. Scapus gracilis semipedalis. Racemus laxus 5–6-pollicaris, bracteis minutis deltoideis, pedicellis erecto-patentibus, inferioribus 3–$3\frac{1}{2}$ poll. longis, superioribus sensim brevioribus. Perianthium 2 lin. longum infundibulare albidum, segmentis ligulatis purpureo-brunneo vittatis. Stamina perianthio triente breviora, filamentis subulatis, antheris minutis subglobosis. Ovarium globosum sessile. *Pungo Andongo, ad ripas fluminis Cumanza, in arenosis dumetosis.* Floret Martio.

4*. E. andongense, Welw. Herb. Tuber globosum 1–$1\frac{1}{2}$ poll. crassum, setis coronatum. Folia solitaria hysteranthia petiolata; petiolus 2–3-pollicaris; lamina subcoriacea oblanceolata glabra 6–8 poll. longa 1–$1\frac{1}{2}$ poll. lata, a medio ad petiolum angustata. Scapi 1–2 palmares vel pedales. Racemi laxi 2–4-pollicares, pedicellis elongatis. Perianthium sulphureum, segmentis purpureo vittatis. Stamina inclusa, 3 interiora breviora. Ovarium sessile ovoideo-trigonum. *Pungo Andongo, in dumetis frequens.* Floret Nov.

12*. E. flexuosum, Welw. Herb. Tuber globosum 6–12 lin. crassum. Folia hysteranthia non vidi. Scapus flexuosus 6–9-pollicaris. Racemus laxus 6–9-pollicaris 20–30-florus, rachi flexuosa, pedicellis erecto-patentibus, inferioribus 2–$2\frac{1}{2}$ poll. longis, superioribus sensim brevioribus, bracteis minutis deltoideis. Perianthium campanulatum 3 lin. longum, segmentis ligulatis albis purpureo vittatis. Filamenta linearia perianthio triente breviora. *Huilla, regio temperata, in pascuis humidiusculis inter Lopollo et Humpata.* Floret Nov.

15*. E. paludosum, Baker. Tuber oblongum vel globosum 9–12 lin. crassum, intus sanguineo-purpureum, fibris densis intertextis persistentibus coronatum. Folia 1–3 synanthia breviter petiolata coriacea glauco-viridia glabra lanceolata vel oblonga 1–2 poll. longa, 6–9 lin. lata, basi rotundata vel subcuneata. Scapus gracilis 4–6-pollicaris. Racemus laxus 3–4-pollicaris, bracteis minutis deltoideis, pedicellis capillaribus ascendentibus 6–12 lin. longis. Perianthium campanulatum 2 lin. longum, segmentis albidis rubro-purpureo vittatis. Filamenta subulata perianthio triente breviora, antheris oblongis minutis. Capsula oblonga perianthio æquilonga. *Pungo Andongo, frequens in paludosis.* Floret Jan.–Mart.

15*. Eriospermum ophioglossoides, Welw. Herb. Tuber globosum, apice fibris copiosis intertextis coronatum. Folia 1–2 synanthia lanceolata glabra coriacea glauco-viridia lanceolata breviter petiolata 1–3 poll. lata, 6–7 lin. longa, basi cuneata. Scapus semipedalis. Racemus laxus 3–4 poll. longus, bracteis minutis deltoideis, pedicellis erecto-patentibus, inferioribus 6–9 lin. longis. Perianthium 3 lin. longum sulphureum, segmentis fusco-purpureo vittatis. Filamenta subulata perianthio triente breviora, antheris minutis oblongis flavis. Stylus filiformis 1 lin. longus. *Huilla, regio temperata, in pascuis humidiusculis.* Floret Nov.

Allium, Linn.

A. (Rhiziridium) angolense, Baker. Bulbi cæspitosi anguste ovoidei 3 poll. longi, 6–9 lin. lati, tunicis brunneis membranaceis. Folia 6–8 erecta anguste linearia glabra glauco-viridia carnoso-herbacea 6–9 poll. longa 1½ lin. lata. Scapus validus pedalis et ultra, medio leviter incrassatus. Spathæ valvæ 2 deltoidæ 3–4 lin. longæ. Umbella densa globosa 2 poll. lata, pedicellis 6–9 lin. longis. Perianthium album campanulatum 2 lin. longum, segmentis oblongis fusco vittatis. Stamina perianthio æquilonga, filamentis conformibus subulatis. *Golungo Alto, in herbidis.* Floret Maio.

Gloriosa, Linn.

G. superba, Linn. *Angola.*

G. virescens, Lindl. *Angola et Sierra Leone.*

Sandersonia, Hook.

S. littonioides, Welw. Herb. Tuber carnosum *Gloriosæ.* Caulis sesquipedalis erectus, dimidio inferiore nudo flexuoso, superiore recto crebre foliato. Folia oblonga acuta subcoriacea viridia amplexicaulia subtiliter nervata 2–4 poll. longa, 1 poll. lata, apice haud cirrosa. Flores ex axillis foliorum superiorum producti solitarii, pedicellis cernuis 1–2 poll. longis. Perianthium aurantiaco-purpureum 9 lin. longum, segmentis lanceolatis maculis atropurpureis tessellatis, basi nectario saccatis. Stamina perianthio duplo breviora, filamentis filiformibus profunde perigynis, antheris versatilibus 1½ lin. longis. Ovarium oblongum 3–4 lin. longum, apice obtuse lobatum; stylus erectus ovario æquilongus, apice tricuspidatus. *Pungo Andongo, in sylvis, alt.* 2400–3800 *pedum.* Habitus *Epipactis latifoliæ.*

Walleria, Kirk.

W. angolensis, Baker. Tuber carnosum difforme. Caulis rectus pedalis vel sesquipedalis, prope basin nudus. Folia 20–30 lanceolata erecto-patentia sessilia modice firma acuminata 3–4 poll. longa 3–6 lin. lata. Pedicelli ex axillis foliorum multorum producti, sæpissime simplices 12–18 lin. longi, raro furcati, ad furcam bractea lanceolata instructi. Perianthium 6–9 lin. longum intense cyaneum, seg-

mentis lanceolatis acutis per totam latitudinem laxe nervatis. Stamina perianthio paulo breviora, antheris linearibus 4 lin. longis. Ovarium basi inferum, loculis 4–7-ovulatis. Capsula cernua. *Huilla, in collinis petrosis, alt.* 3800–5500 *pedum.*

Intermediate between *W. nutans* and *W. Mackenzii* of Zambesi-land. They may likely prove all three, as Dr. Welwitsch suggested to me, varieties of a single species.

HAWORTHIA, Duval.

H. ANGOLENSIS, Baker. Bulbus squamis fuscis carnosis ovato-lanceolatis 15–18 lin. longis dense imbricatis prædítus, fibris radicalibus cæspitosis carnosis. Folia 6–12 synanthia rosulata erecta linearia 2–3 poll. longa glauca planiuscula, margine serrulata, dentibus minutis retrorsis. Scapus semipedalis. Racemus subspicatus laxus 4–5-pollicaris, floribus erecto-patentibus, bracteis deltoideis cuspidatis 3 lin. longis. Perianthium 6 lin. longum, segmentis ligulatis obtusis late viridi vittatis tubo multo brevioribus. *Huilla, regio subtemperata, in dumetis arenosis.* Floret Nov.

ALOË, Linn.

A. ANGOLENSIS, Baker. Subacaulis. Folia dense rosulata ensiformia bipedalia glauca immaculata 15–24 lin. lata acuminata, dentibus deltoideis patulis corneis 1 lin. longis. Scapus bipedalis, valde compressus, basi 1 poll. crassus. Racemi 1–3 densi 3–4 poll. longi, pedicellis $1\frac{1}{2}$–3 lin. longis, bracteis deltoideo-lanceolatis, floribus inferioribus deflexis. Perianthium sulphureum 9–10 lin. longum. Stamina inclusa. *Burro do Bengo, in collinis sylvaticis.* Floret Julio.

A. ANDONGENSIS, Baker. Caulis 1–2-pedalis 2- vel 3-partitus, ramis ascendentibus. Folia dense rosulata lanceolata glauca immaculata arcuato-recurvata 8–9 poll. longa, basi 15–18 lin. lata, dentibus parvis deltoideis cuspidatis corneis armata. Panicula deltoidea, racemis densis 2–3 poll. longis, pedicellis 3–4 lin. longis, bracteis lanceolatis pedicello æquilongis. Perianthium 7–8 lin. longum luteo-rubrum. Stamina inclusa. *Pungo Andongo, in rupestribus frequens.* Floret Jan.–April.

A. LITTORALIS, Baker. Arborescens 6–10-pedalis, trunco sæpissime simplici, brachii, rarius femoris humani crassitie. Folia dense rosulata ensiformia 2–3-pedalia acuminata immaculata 2–$2\frac{1}{2}$ poll. lata, dentibus patulis corneis lanceolatis vel deltoideis 1 lin. longis armata. Scapus 4–5-pedalis, sursum paniculatus. Racemi pedales modice densi, pedicellis 3–4 lin. longis, bracteis lanceolato-deltoideis 4–6 lin. longis, inferioribus reflexis. Perianthium 1 poll. longum. Stamina demum leviter exserta. *Loanda, totius regionis littoralis in collinis aridis frequens.* Floret Maio–Julium.

A. PALMIFORMIS, Baker. Fruticescens, caule 3–5-pedali, basi simplici, interdum superne ramoso. Folia dense rosulata ensiformia glauco-viridia immaculata pedalia et ultra, basi 21–24 lin. lata, dentibus deltoideis corneis patulis crebris 2 lin. longis armata. Scapus simplex vel ramosus, racemis modice densis 50–60-floris 6–8 poll. longis,

floribus inferioribus cernuis, pedicellis 3–6 lin. longis, bracteis minutis deltoideis cuspidatis. Perianthium splendide rubrum 9–10 lin. longum. Stamina inclusa. *Huilla, regio subtemperata, in petrosis sylvaticis editioribus, Morro do Lopollo.* Floret Aprili. Cum tribus præcedentibus ad stirpem *A. abyssinicæ* referendum.

ALOË ZEBRINA, Baker. Breviter caulescens, caule simplici semipedali 1–2 poll. crasso. Folia dense rosulata patula lanceolata acuminata glauca albo-lineata et maculis albis inordinate seriatis utrinque decorata semipedalia vel pedalia, basi $1\frac{1}{2}$–2 poll. lata, dentibus deltoideis corneis $1\frac{1}{2}$–2 lin. longis armata. Scapus 3–4-pedalis, sursum paniculatus, racemis laxis 6–12 poll. longis, pedicellis 3–6 lin. longis, bracteis lanceolatis acuminatis 3–4 lin. longis. Perianthium lateritium 9–12 lin. longum. Stamina inclusa. *Barro do Bengo, Loanda et Lebongo.* Ad *A. pictam* capensem affinis.

A. PLATYPHYLLA, Baker. Breviter caulescens, caule simplici semipedali vel pedali. Folia dense rosulata ovato-lanceolata acuminata glauco-viridia dense lineata et albo-maculata semipedalia, basi $2\frac{1}{2}$–3 poll. lata, dentibus deltoideis crebris corneis $1\frac{1}{2}$ lin. longis armata. Scapus 3–4-pedalis, racemis laxis semipedalibus vel pedalibus, bracteis lanceolatis, pedicellis 5–6 lin. longis. Perianthium rubrum 12–15 lin. longum. Stamina inclusa. *Pungo Andongo, in dumetis siccis frequens.* Floret Aprili. An sit varietas latifolia grandiflora prioris?

Order SMILACEÆ.

SMILAX, Linn.

S. KRAUSSIANA, *Hochst.* *Huilla, Ambaca, Benguella et Golungo Alto.* Floret Feb.

Order HÆMADORACEÆ.

XEROPHYTA, Commers.

X. CAPILLARIS, Baker. (Plate XXXVI. fig. 1). *Vellosia (Ophiothamna) capillaris,* Welw. Herb. Arbuscula, ramulis lignosis 5–6 lin. crassis, basibus foliorum delapsorum brunneis truncatis crebre nervatis. Folia ad rosulam producta 4–8 linearia longe aristata coriacea glabra 4–6 poll. longa 3 lin. lata crebre nervata. Pedicelli cæspitosi 2–3 poll. longi dense atro-viscosi. Ovarium turbinatum 3 lin. longum dense atro-viscosum. Perianthium albidum 15–18 lin. longum, segmentis lanceolatis acuminatis basi 3 lin. latis. Antheræ lineares 5–6 lin. longæ, filamento brevissimo. Capsula oblonga 5–6 lin. lata dense viscosa. *Huilla, in dumetis editioribus ad sylvas de Monino et in alta planitie de Empalanca, alt.* 3800–5500 *pedum.*

X. SQUARROSA, Baker. *Vellosia (Ophiothamna) squarrosa,* Welw. Herb. Frutex 3–4-rarius 5-pedalis, trunco basi $1\frac{1}{2}$–2 poll. crasso, basibus foliorum delapsorum sæpe

squarrosis. Folia producta linearia acuminata coriacea 5–6 poll. longa 5 lin. lata, marginibus superne denticulatis. Pedunculi uniflori 4–5 poll. longi superne dense viscosi. Ovarium clavatum 4-4½ lin. longum densissime atro-viscosum. Perianthii limbus 9–12 lin. longus, segmentis lanceolatis albo-cæruleis. Antheræ lineares subsessiles, perianthio duplo breviora. Capsula oblonga crustacea densissime atro-viscosa ½ poll. crassa. *Pungo Andongo, in declivis rupestribus editioribus ipsius Præsidii gregaria.*

XEROPHYTA VELUTINA, Baker. *Vellosia* (*Ophiothamna*) *velutina*, Welw. Herb. Frutex erectus 1½–2½-pedalis, ramis 6–9 lin. crassus, basibus foliorum delapsorum rigidis adpressis truncatis mucronatis. Folia producta ad rosulam 8–10 linearia vel lanceolata 6–10 poll. longa 3–6 lin. lata coriacea crebre nervata distincte costata utrinque subtiliter pilosa. Pedunculi 1½–2 poll. longi, sursum atro-viscosi. Ovarium clavatum 3 lin. longum dense atro-viscosum. Perianthii limbus pollicaris cæruleus, segmentis lanceolatis acuminatis. Stamina perianthio subduplo breviora, antheris linearibus, filamentis brevissimis. *Pungo Andongo, alt.* 2400–3800 *pedum, in rupestribus arenoso-schistosis juxta ripas fluminis Cuanza gregaria, sed rarius florifera.*

X. STENOPHYLLA, Baker. *Vellosia* (*Ophiothamna*) *stenophylla*, Welw. Herb. Fruticosa, ramis 6–9 lin. crassus, basibus foliorum delapsorum rigidis adpressis crebre nervatis apice truncatis eroso-dentatis. Folia ad rosulam 6–8 rigidissima triquetra facie canaliculata 6–8 poll. longa 1–1½ lin. lata glabra acuminata creberrime nervata dorso scabridula. Flores non vidi. *Mossamedes, in montosis petrosis arenoso-schistosis prope Cazemba, dense gregaria.*

Order HYPOXIDACEÆ.

HYPOXIS, Linn.

H. ANGUSTIFOLIA, Lam. *Pungo Andongo et Huilla, regio temperata, in herbidis arenosis.*

H. CUANZENSIS, Welw. Herb. Tuber perenne 1½–2 poll. longum, 1 poll. crassum fibris setosis coronatum. Folia 8–10 linearia rigida parce pilosa distincte multinervata pedalia vel sesquipedalia 2 lin. lata. Scapi 2–4ni 3–4-pollicares. Corymbus 3–4-florus, bracteis setaceis pilosis 5–6 lin. longis, pedicellis 2–3 lin. longis. Ovarium turbinatum 1½ lin. longum, pilis brunneis vestitum. Perianthii limbus luteus 3 lin. longus, segmentis exterioribus dorso pilosis. *Pungo Andongo, in pratis humidis.* Floret Martio.

H. CANALICULATA, Baker. Tuber perenne oblongum 9–12 lin. crassum, fibris et squamis brunneis coronatum. Folia plura rigida erecta subteretia facie canaliculata 3–6 poll. longa ½ lin. lata, supra basin glabra contorta. Scapi 6–8 graciles albo-pilosi biflori 1–1½ poll. longi. Pedicelli 2–3 lin. longi dense pilosi, bracteis minutis subulatis

suffulti. Ovarium turbinatum 2 lin. longum, pilis albis dense vestitum. Perianthii limbus luteus 4 lin. longus, segmentis exterioribus dorso pilosis. Stamina perianthio duplo breviora. Capsula medio circumscissa. *Huilla, regio subtemperata, in pascuis collinis arenosis prope Lopollo, frequens.* Floret Dec.–Jan.

HYPOXIS MONANTHOS, Baker. Tuber perenne oblongum 3 lin. crassum, fibris radicalibus carnosis. Folia 4–5 anguste linearia parce albo-pilosa 4–5 poll. longa, basi ½–1 lin. lata. Pedunculi uniflori 1–3ni 1½–2 poll. longi parce pilosi gracillimi. Ovarium turbinatum 1 lin. longum subtiliter pilosum. Perianthii limbus luteus 2 lin. longus, segmentis exterioribus dorso viridulis subtiliter pilosis. Genitalia limbo duplo breviora. Capsula oblonga 3 lin. longa. *Huilla, regio temperata, in herbidis prope rivulum de Lopollo.* Floret Dec.

H. ANGOLENSIS, Baker. Tuber perenne oblongum 3 poll. longum, 1–1½ poll. crassum, setis densis sæpe coronatum. Folia 6–8 linearia rigida acuminata 6–9 poll. longa 2–3 lin. lata, ad margines et costam faciei inferioris solum albo-pilosa. Pedunculi 1–4ni 3–6 poll. longi, pilis albidis ascendentibus vestiti. Flores 6–8 in racemum 3–4 poll. longum dispositi, bracteis linearibus 3–6 lin. longis, pedicellis 3–6 lin. longis. Ovarium turbinatum 3 lin. longum, pilis densis albis ascendentibus vestitum. Perianthii limbus luteus 6 lin. longus, segmentis interioribus oblongis, exterioribus lanceolatis dorso dense pilosis. Stamina perianthio duplo breviora, antheris lanceolatis sagittatis, filamentis deltoideis brevissimis. *Huilla, regio subtemperata, in collinis dumetosis prope Lopollo, frequens.* Floret Oct.–Nov.

H. POLYSTACHYA, Welw. Herb. Tuber globosum vel depresso-globosum 3 poll. longum, basibus membranaceis brunneis foliorum delapsorum coronatum. Folia 10–12 rigida ensiformia pedalia vel sesquipedalia acuminata medio 8–9 lin. lata, facie glabra, dorso tenuiter pilosa. Pedunculi 6–8ni crassi 4–6 poll. longi. Racemus densus 20–30-florus 3–4-pollicaris, pedicellis 6–12 lin. longis, bracteis subulatis sericeis 6–9 lin. longis. Ovarium turbinatum 3 lin. longum breviter albo-pilosum. Perianthii limbus luteus 6 lin. longus, segmentis exterioribus dorso tenuiter pilosis. Stamina limbo duplo breviora, antheris basi sagittatis filamentis longioribus. Capsula sub apicem circumscissa. *Huilla, in collinis dumetosis inter Lopollo et Catumba.* Floret Dec.

Var. ANDONGENSIS, Baker. Folia angustiora 5–6 lin. lata, dorso dense albo-pilosa. Pedunculus compressus sesquipedalis. *Pungo Andongo.*

CURCULIGO, Gaertn.

C. GALLABATENSIS, Schweinf. Pl. Callab. Exsic. no. 39. Tuber oblongum perenne 2 poll. longum, 6–9 lin. crassum, fibris radicalibus carnosis. Folia producta 3 lanceolata erecta subpetiolata plicata utrinque tenuiter pilosa pedalia, medio 6–10 lin. lata.

Flores radicales, singuli bracteis binis linearibus vel lanceolatis 15–18 lin. longis præditi, ovario piloso cylindrico, tubo supra ovarium filiformi 15–18 lin. longo, limbo luteo 4 lin. longo, segmentis lanceolatis, exterioribus dorso pilosis. Genitalia limbo triente breviora. Stylus complanatus apice stigmatoso-capitatus. Bacca oblonga 5–6 lin. longa. *Golungo Alto, ad dumetorum margines ad Queta.* Floret Nov.

May prove a variety of *Gethyllis pilosa*, Schum. & Thonn. Pl. Guin. 172, of which we have specimens at Kew gathered by Barter.

Order IRIDACEÆ.

GLADIOLUS, Linn.

G. CÆRULESCENS, Baker. Bulbus globosus 8–9 lin. longus, tunicis crassis verticaliter scissis. Caulis gracilis sesquipedalis. Folia 3–4 distantia superposita, infimum productum lineare acuminatum rigidum glabrum 3–4 poll. longum 1 lin. latum, superiora rudimentaria brevissima. Spica laxa secunda 2–3-flora, spathæ valvis oblongis obtusis 6–8 lin. longis viridibus margine membranaceis, interiore paulo minore. Perianthium sordide cærulescens, tubo curvato 5–6 lin. longo, limbo horizontali tubo æquilongo, segmentis superioribus oblongis obtusis 3–4 lin. latis, inferioribus angustioribus lanceolatis. Genitalia limbo subæquilonga, antheris 3 lin. longis. *Huilla, regio subtemperata, in cultis anno elapso adhuc dumetis sylvestribus, ad Lopollo.*

G. LURIDUS, Welw. Herb. Bulbus globosus 1 poll. crassus, fibris deorsum parallelis, superne reticulatis. Caulis gracilis pedalis. Folia basalia subcontigua 3–4 anguste linearia rigida glabra acuminata 1 lin. lata. Inflorescentia simplex vel ramosa. Spica secunda 3–7-pollicaris, spathæ valvis lanceolatis viridibus purpureo tinctis 6–8 lin. longis, interiore paulo minore. Perianthii cærulei tubus 5–6 lin. longus curvatus, limbo horizontali tubo æquilongo, segmentis superioribus oblongo-spathulatis obtusis 3–4 lin. latis, inferioribus magis unguiculatis. Genitalia limbo æquilonga, antheris 3 lin. longis. *Huilla, regio subtemperata, in arvis* Zeæ Maydis *prope Lopollo.* "Color florum exacte sicut in *Iride lurida*," Welw.

G. BREVICAULIS, Baker. Bulbus globosus 1 poll. crassus, tunicis subtiliter fibrosis. Folia rosularum basalium 3 anguste linearia firma glabra semipedalia vel pedalia 3–4 lin. lata. Caulis 6–8-pollicaris, foliis paucis superpositis valde reductis solum præditus. Spica simplex secunda 6–9-pollicaris 6–15-flora, sursum subdensa, spathæ valvis lanceolatis acutis viridibus 6–9 lin. longis margine scariosis, interiore paulo minore. Perianthium violaceo-purpureum, tubo semipollicari, limbo horizontali pollicari, segmentis superioribus oblongo-spathulatis obtusis 5–6 lin. latis, inferioribus obovato-unguiculatis. Stamina perianthio triente breviora, antheris

4 lin. longis. *Huilla, regio temperata, in pratis arenosis subhumidis inter Lopollo et Humputa, frequens.* Floret Dec.–Jan.

Habitus *G. imbricati* et *G. palustris* europæi.

GLADIOLUS LAXIFLORUS, Baker. Bulbus globosus 6–9 lin. crassus, tunicis brunneis membranaceis. Folia glabra linearia falcata rigide coriacea 6–15 poll. longa 3–4 lin. lata, nervis et marginibus stramineis incrassatis. Inflorescentia simplex vel furcata. Spica laxissima 4–8-pollicaris pauciflora, rachi flexuosa, internodiis inferioribus 1½–2 poll. longis, spathæ valvis 6–9 lin. longis purpureo tinctis acutis vel subobtusis. Perianthium læte roseo-purpureum, tubo curvato semipollicari, limbo pollicari horizontali, segmentis oblongo-spathulatis obtusis subæqualibus 3–4 lin. latis. Genitalia limbo paulo breviora. Capsula obovoidea 8–9 lin. longa. *Huilla, in pratis paludosis alte herbidis, imprimis circa stagna juxta rivum de Lopollo.* Floret Dec.

Habitus etiam *G. imbricati* europæi.

G. GREGARIUS, Welw. Herb. Bulbus globosus 8–9 lin. crassus, tunicis subtiliter fibrosis contextis. Folia subbasalia rosulata 5–6 linearia glabra 6–9 poll. longa, 3 lin. lata. Caulis pedalis vel sesquipedalis. Spica simplex secunda erecta striata 5–8-pollicaris 10–12-flora, spathæ valvis lanceolatis, exteriore pollicari vel sesquipollicari, interiore minore. Perianthium luteum, intus ad faucem maculis parvis 2 violaceis guttatum, tubo semipollicari curvato, limbi 9 lin. longi segmentis superioribus oblongo-spathulatis 4–4½ lin. latis, inferioribus oblongo-unguiculatis. Genitalia limbo paulo breviora, antheris 4 lin. longis. *Pungo Andongo, in rupestribus editioribus de Serra de Pedras de Guinga.* Floret Jan.–Martium. "Crescit cæspitosus, bulbis 4–10 dense gregatis." Welw.

G. BENGUELLENSIS, Baker. Bulbus globosus longe rhizomatosus, tunicis brunneis membranaceis. Folia basalia subrosulata anguste ensiformia dura glabra 6–9 poll. longa 6–8 lin. lata, nervis et marginibus crassis stramineis. Caulis pedalis et ultra, foliis 2–3 reductis præditus. Spica laxa secunda 6–8-flora 6–8-pollicaris, spathæ valvis brunneis scariosis lanceolatis acutis 9–15 lin. longis. Perianthium splendide rubrum, fauce aurantiaco-purpureo maculatum, tubo curvato 8–9 lin. longo, limbi segmentis 9–12 lin. longis horizontalibus, segmentis superioribus ovatis acutis 6 lin. latis, inferioribus lanceolato-spathulatis flore expanso deflexis. Genitalia perianthio paulo breviora. Capsula (immatura) oblongo-clavata 8–9 lin. longa. *Huilla, regio temperata, in pascuis dumetosis siccioribus prope Lopollo.* Dec.–Feb. Bulbus rhizomatosus more *Lilii canadensis.*

G. WELWITSCHII, Baker. *G. splendens*, Welw. Herb., non Baker in Trimen Journ. 1876, 333. Bulbus globosus 15–18 lin. crassus, tunicis fibrosis. Folia rosularum basalium haud floriferarum linearia acuminata glabra rigide coriacea 9–15 poll. longa 3–4 lin. lata, nervis et marginibus crassis stramineis. Caulis semipedalis,

foliis rudimentariis solum prædītus. Spica laxa secunda 6–10-pollicaris, spathæ valvis lanceolatis acutis 1½–2 poll. longis purpureo tinctis, interiore minore. Perianthium splendide rubro-aurantiacum, fauce maculatum, tubo curvato sesquipollicari, limbi bipollicaris segmentis superioribus horizontalibus ovatis acutis 10–12 lin. latis, inferioribus lanceolatis deflexis. Genitalia limbo paulo breviora, antheris 5–6 lin. longis. Capsula obovoideo-oblonga 15 lin. longa, seminibus oblongis late alatis. *Huilla, regio temperata, in collinis dumetosis argillaceo-arenosis circa Lopollo.* Floret Oct.–Nov.

GLADIOLUS MULTIFLORUS, Baker. Bulbus globosus 12–18 lin. crassus, tunicis fibroso-crispatis. Folia basalia rosulato-disticha ensiformia modice firma 9–12 poll. longa 6–9 lin. lata, nervis vix incrassatis. Caulis pedalis. Spica densa stricta secunda pedalis, spathæ valvis brunneis lanceolatis acutis 10–12 lin. longis. Perianthium rubro-purpureum, fauce pallidiore, tubo semipollicari abrupte curvato, limbo 9–10 lin. longo, segmentis superioribus brevioribus oblongo-spathulatis, inferioribus longioribus oblanceolato-unguiculatis. Genitalia limbo vix breviora, antheris 3 lin. longis. Capsula clavata 8–9 lin. longa. *Huilla, regio temperata, in sylvis,* Protearum, *loco dicto Monino, cæspitosis.* Floret Feb. Ad *G. spicatum*, Klatt, accedens.

G. ANGOLENSIS, Welw. Herb. Bulbus globosus 12–18 lin. crassus, tunicis fibris parallelis prædītis. Folia superposita linearia vel ensiformia glabra rigide coriacea, inferiora sesquipedalia vel bipedalia 6–9 lin. lata, nervis et marginibus stramineis incrassatis. Caulis 3–4-pedalis et ultra. Spica laxa secunda 6–18-pollicaris, spathæ valvis brunneis lanceolatis acutis 1½–2 poll. longis, interiore paulo minore. Perianthium luteum dense rubro maculatum, tubo curvato sesquipollicari, limbi horizontalis 18–21 lin. longi segmentis superioribus oblongo-spathulatis, superiore maximo dorso convexo 12–15 lin. lato, inferioribus minoribus flore expanso decurvatis, omnibus obtusis. Genitalia limbo triente breviora. Capsula clavata 15–18 lin. longa ad basin trivalvis, valvis persistentibus divaricatis. *Golungo Alto et Pungo Andongo, in graminosis frequens.* Floret Feb.

Ad *G. psittacinum* accedens. Præterea legit Monteiro.

G. QUARTINIANUS, A. Rich. *Huilla, regio temperata, in pratis sylvaticis inter Lopollo et lacum Ivantella.* Floret Dec.

G. ANDONGENSIS, Welw. Herb. Bulbus globosus 1 poll. crassus, tunicis brunneis fibris parallelis prædītis. Folia ensiformia rigide coriacea acuta pedalia 10–12 lin. lata, nervis et marginibus crassis stramineis. Caulis subpedalis. Spica laxa 6–8-pollicaris, spathæ valvis lanceolatis acutis brunneis 12–18 lin. longis. Perianthium aurantiacum, tubo curvato 15 lin. longo, limbi sesquipollicaris segmentis superioribus oblongo-spathulatis horizontalibus, superiore maximo dorso convexo 10–12 lin. lato, inferioribus minoribus decurvatis. *Pungo Andongo, alt.* 2400–3800 *pedum, in rupestribus editioribus ipsius Præsidii.* Floret Dec.

ANTHOLYZA, Linn.

A. HUILLENSIS, Welw. Herb. Bulbus globosus 9–12 lin. crassus, tunicis pallide brunneis sursum membranaceis deorsum fibris parallelis præditis. Caulis 6–15-pollicaris, foliis 3 superpositis lineari-subulatis, inferiore 3–4 poll. longo, præditus. Spica 4–8-pollicaris laxa secunda, spathæ valvis brunneis obtusis 6–7 lin. longis. Perianthium splendide rubrum, tubo pollicari dimidio superiore cylindrico, limbi segmento superiore oblongo-spathulato 8–9 lin. longo, lateralibus superioribus oblongis 3 lin. longis, tribus inferioribus parvis lanceolatis. Genitalia segmento superiore paulo breviora. Capsula obovoideo-oblonga semipollicaris, seminibus discoideis distincte alatis. *Huilla, regio temperata, in dumetis arenoso-petrosis apricis inter Lopollo et Humpata.*

Ad *A. Cunoniam* accedens.

ARISTEA, Soland.

A. ANGOLENSIS, Baker. Folia basalia linearia distiche rosulata 6–9 poll. longa 3–4½ lin. lata glabra crebre nervata. Caulis simplex anceps pedalis vel sesquipedalis, foliis pluribus basalibus similibus præditus. Inflorescentia pedalis anguste paniculata, floribus multis in capitulum confertis, capitulis terminalibus pedunculatis, lateralibus sessilibus, bracteis deltoideis membranaceis 3–4 lin. longis, exterioribus longioribus, dorso firmulis. Perianthii cærulei limbus cæruleus semipollicaris, segmentis post anthesin contortis. Capsula sessilis oblonga 3 lin. longa. *Huilla, alt.* 3800–5500 *pedum, in pratis herbidis juxta ripas rivi de Lopollo.* Floret Febr.–Maium.

MORÆA, Linn.

M. TEXTILIS, Baker. *Iridopsis textilis*, Welw. Herb. Bulbus globosus 1½–2 poll. latus, tunicis multis, fibris atris duris præditis. Folium basale lineare solitarium glabrum rigidum distincte multinervatum 4–5-pedale 4½–6 lin. latum. Caulis teres 2–3-pedalis simplex, foliis pluribus rudimentariis præditus. Spathæ 3–5-floræ 4–5-pollicares, valvis scariosis purpureis crebre nervatis, interiore majore. Pedicelli elongati demum exserti. Ovarium clavatum pollicare. Perianthii tubus supra ovarium nullus; limbi saturate purpurei 2½–3 poll. longi segmentis oblanceolato-spathulatis 5–6 lin. latis, exterioribus reflexis, interioribus erectis apice emarginatis. Stigmata 1½ poll. longa, cristis lanceolatis 5–6 lin. longis. Filamenta 8–9 lin. longa, dimidio inferiore monadelpha. *Huilla, alt.* 3800–5500 *pedum, in collinis dumetosis humidiusculis juxta rivum de Lopollo.* Floret Aprili.

Ad *M. diversifoliam*, Baker, abyssinicam accedens. *Iridopsis*, Welw. Herb. est stirps generis *Moræa* floribus magnis persistentibus, caulibus robustis elatis, ovario clavato.

M. WELWITSCHII, Baker. Tuber globosum 10–12 lin. crassum, tunicis brunneis rigide fibrosis supra collum longe productis. Folia linearia acuta rigida pallide viridia glabra distincte multinervata 1½–2½-pedalia, 5–6 lin. lata. Caulis pedalis simplex haud foliatus. Spathæ terminales bifloræ, valvis acutis scariosis subæqualibus

3–4 poll. longis. Pedicelli 2–4-pollicares. Ovarium clavatum pollicare. Perianthii tubus supra ovarium nullus, limbi saturate lilacini persistentis 2 poll. longi segmentis oblanceolato-spathulatis subæqualibus 5–6 lin. latis, exterioribus flore expanso falcatis, interioribus erectis. Stigmata 12–15 lin. longa, cristis lanceolatis 5–6 lin. longis. Filamenta 8–9 lin. longa, dimidio inferiore monadelpha, antheris 5–6 lin. longis. Capsula oblonga 15 lin. longa. *Huilla, regio temperata in uliginosis et paludosis juxta rivum de Lopollo.* Floret Nov. "Irides quasdam europæas perfecte ludens," Welw.

MORÆA GLUTINOSA, Baker. Tuber difforme 9–18 lin. crassum. Folia rosularum basalium haud floriferarum anguste ensiformia firma glabra pedalia 4–5 lin. lata. Caulis semipedalis, foliis 3–4 reductis præditus. Inflorescentia pedalis, ramis 3–4 elongatis ascendentibus, infra nodos viscosis. Spathæ valvæ oblongæ obtusæ virides arcte complicatæ, interior longior 12–15 lin. longa. Pedicelli spathæ æquilongi. Perianthii tubus supra ovarium nullus; limbi pollicaris fugacis lilacino-purpurei segmentis oblanceolato-spathulatis subæqualibus. Filamenta semipollicaria infra medium connata, antheris flavis 1 lin. longis. *Huilla, regio subtemperata, in collinis dumetosis prope Lopollo, cum* Clematibus *et* Tinneæ *sp.* Floret Aprili.

M. SPITHAMÆA, Baker. Tuber globosum 3–6 lin. crassum. Caulis gracilis palmaris, basi foliis 2–3 anguste linearibus rudimentariis præditus, dimidio superiore ramosus, ramis 2–3 infra nodos et spathas viscosis. Spathæ 2–3 terminales pollicares trifloræ, valvis firmis viridulis striatis, exteriore minore semipollicari. Pedicelli spathæ æquilongi. Perianthii tubus supra ovarium nullus, limbi flavi fugacis 7–9 lin. longi intus maculis nigris decorati, segmentis oblanceolato-spathulatis subæqualibus. Filamenta 4½ lin. longa prope basin connata, antheris oblongis 1 lin. longis. *Huilla, regio subtemperata, in dumetis arenosis circa Lopollo et Humpata.*

M. ANDONGENSIS, Baker. Tuber parvum globosum, fibris multis gracilibus præditum, Caulis semipedalis vel pedalis, dimidio superiore ramosus, infra nodos et spathas viscosus, foliis 2 anguste linearibus glabris rigide coriaceis 6–15 poll. longis 1 lin. latis præditus, ramis paucis vel pluribus (2–8) arcuatis ascendentibus 1–3 poll. longis. Spathæ terminales 6–9 lin. longi, valva exteriore 4½–6 lin. longa. Pedicelli spathæ æquilongi. Ovarium turbinatum 1 lin. longum. Perianthii tubus supra ovarium nullus; limbi sulphureo-lutei fugacis semipollicaris segmentis oblanceolato-spathulatis subæqualibus. Filamenta 3 lin. longa supra medium connata, antheris oblongis 1 lin. longis. Capsula depresso-globosa 4 lin. lata. *Pungo Andongo, alt.* 2400–3800 *pedum, in pratis sylvaticis paludosis breviter herbidis de Montollo.*

M. CANDELABRUM, Baker. Tuber parvum globosum. Caulis 2–3-pedalis, dimidio superiore pinnatim ramosus, ramis gracilibus erecto-patentibus infra nodos viscosis, inferioribus compositis, ramulis ultimis strictis erectis 1–3 poll. longis. Folia plura superposita acuta firma glabra linearia pedalia 3 lin. lata. Spathæ 4–5-floræ, valvis

valde inæqualibus, interiore pollicari, exteriore obtusa 3–4 lin. longa. Pedicelli spathæ æquilongi. Ovarium turbinatum 1 lin. longum. Perianthii tubus supra ovarium nullus; limbi lilacini fugacis segmentis oblanceolato-spathulatis subæqualibus. Stamina limbo dimidio breviora, filamentis dimidio inferiore connatis, antheris oblongis. *Huilla, regio subtemperata, in fruticetis petrosis ad Morro de Lopollo, alt.* 5200 *pedum.*

MORÆA GRACILIS, Baker. Bulbi globosi cæspitosi 5–6 lin. lati tunicis subtiliter fibroso-reticulatis. Caulis strictus gracilis simplex 8–15-pollicaris, supra basin folio unico anguste lineari præditus, infra nodos haud viscosus. Spathæ solitariæ terminales 1–6-floræ, valvis lanceolatis 2–2½ poll. longis, exteriore breviore. Pedicelli spathe demum æquilongi. Ovarium clavatum 3 lin. longum. Perianthii tubus supra ovarium nullus; limbus luteus fugax 9 lin. longus, segmentis oblanceolato-spathulatis subæqualibus. Stamina limbo duplo breviora, filamentis dimidio inferiore connatis. Capsula oblonga 4–4½ lin. longa. *Huilla, in pascuis arenosis prope Lopollo, alt.* 3800–5500 *pedum.*

LAPEYROUSIA, Pourret.

L. LITTORALIS, Baker. Caulis tripollicaris valde ramosus, foliis 2 linearibus acutis firmis glabris infra inflorescentiam instructus, rachi angulosa flexuosa, spathis plerisque pedunculatis terminalibus, 1–2 lateralibus sessilibus. Spathæ valvæ semipollicares lanceolatæ viridulæ æquales. Perianthium non vidi. Capsula membranacea obovoideo-oblonga 3–4 lin. longa. *Mossamedes, in collinis sabulosis maritimis.*

L. ABYSSINICA, Baker. *Montbretia abyssinica*, R. Br. *Pungo Andongo, alt.* 2400–3800 *pedum.*

L. CYANESCENS, Baker. *Psilosiphon cyanescens*, Welw. Herb. Bulbus globosus 1 poll. latus, tunicis fibris crassis præditis. Caulis infra inflorescentiam 6–9-pollicaris, foliis 3–4 anguste linearibus firmis glabris pedalibus 2 lin. latis, nervis 5–7 crassis stramineis præditis. Inflorescentia pedalis, rachi flexuosa ancipiti. Spathæ valvæ lanceolatæ æquales 15–18 lin. longæ. Perianthii tubus filiformis 4–5-pollicaris, limbi albi violaceo tincti pollicaris segmentis oblongis 4–4½ lin. latis. Genitalia limbo duplo breviora, antheris linearibus 4 lin. longis, filamentis brevissimis. *Huilla, regio subtemperata, in collinis spongiosis editis prope Humpata.*

L. FRAGRANS, Baker. *Psilosiphon fragrans*, Welw. Herb. Bulbus ovoideus 8–9 lin. latus, tunicis crassis brunneis reticulato-fibrosis. Caulis brevissimus, foliis 2 linearibus subcoriaceis acutis profunde nervatis glabris 6–8 poll. longis 2 lin. latis instructus. Inflorescentia laxissima corymbosa 6–9 poll. longa, rachi flexuosa angulosa. Spathæ valvæ lanceolatæ subpollicares subæquales integræ acutæ. Perianthium albidum, tubo cylindrico 4–4½ poll. longo, segmentis lanceolatis acutis

9–12 lin. longis. Antheræ $4\frac{1}{2}$ lin. longæ, filamentis brevissimis. Capsula oblonga tubulosa 5–6 lin. longa. *Huilla, regio subtemperata, in rupestribus et petrosis apricis prope Lopollo.*

Lapeyrousia odoratissima, Baker. (Plate XXXVI. figs. 2, 3.) *Psilosiphon odoratissimus*, Welw. Herb. Bulbus ovoideus basi applanatus, tunicis brunneis coriaceis reticulatonervatis, collo 2–3-pollicari. Caulis 1–2-pollicaris, foliis 2–3 linearibus glabris erecto-patentibus 4–5 poll. longis 1 lin. latis, facie profunde canaliculatis. Spica solitaria densa multiflora. Spathæ valva exterior linearis viridis 3–5-pollicaris, interior multo minor. Perianthii albidi fragrantis tubus cylindricus 4–5-pollicaris, limbi segmentis lanceolatis 12–15 lin. longis. Antheræ ligulatæ 3 lin. longæ, filamentis brevissimis. *Huilla, regio subtemperata, in dumetis arenosis petrosis prope Lopollo.*

DESCRIPTION OF PLATES.

Plate XXXIV.

Figs. 1 to 3. *Dipcadi comosum*, Welw. 1. Plant, of natural size. 2. Single perfect flower from the lower part of the raceme, enlarged. 3. Unexpanded raceme.

Figs. 4 to 7. *Acrospira asphodeloides*, Welw. 4. Of natural size. 5. Segment of perianth, enlarged. 6. Stamen; and 7. Pistil in section, also enlarged.

Plate XXXV

Figs. 1 to 6. *Dasystachys campanulata*, Baker. 1. Of natural size. 2. Segment of perianth; 3. Stamen; 4. Ovary: all magnified.

Figs. 5 to 10. *Dasystachys colubrina*, Baker. 5. Plant, of natural size. 6. Segment of perianth; 7. Stamen; 8. Ovary; 9. A horizontal section of ovary; 10. The seed: all magnified.

Plate XXXVI.

Fig. 1. *Xerophyta capillaris*, Baker. Nat. size.

Figs. 2 & 3. *Lapeyrousia odoratissima*, Baker. Of natural size.

The above figures were drawn on stone, partly from sketches by Mrs. J. G. Baker, and partly from the objects themselves, kindly placed at the author's disposal by the Trustees of the late Dr. Welwitsch.

J N Fitch lith.

1-3 DIPCADI COMOSUM. 4-7 ACROSPIRA ASPHODELOIDES

Fitch imp.

J.N.Fitch lith.

1-4 DASYSTACHYS CAMPANULATA. 5-10 D. COLUBRINA.

Fitch imp.

J.N.Fitch lith. 1 XEROPHYTA CAPILLARIS. 2,3. LAPEYROUSIA ODORATISSIMA. Fitch imp.

XVIII. *Contribution to the Lichenographia of New Zealand. By* Charles Knight, *Esq., F.L.S., Auditor-General of New Zealand.*

(Plates XXXVII., XXXVIII.)

Read March 1st, 1877.

Urceolaria novæ-zelandiæ, Kn. (Plate XXXVII. fig. 1.)

Thallus cinerascens indeterminatus leproso-areolatus v. quasi detritus. Apothecia parva immersa, disco subdepresso fusco farinaceo (margine thallode nullo) nucleo ab excipulo dimidiato-fusco cincto, paraphysibus distinctis rectis tenuibus. Sporæ in ascis cylindraceis fuscæ ovatæ murali-divisæ horizontaliter 5–6-septatæ longit. ·027 mm., crassit. ·018 mm. Ad saxa.

Pertusaria graphica, Kn. (Plate XXXVII. fig. 2.)

Thallus late effusus cartilagineus albicans v. cinereo-albicans rimuloso-areolatus, verrucis subgloboso-difformibus crebris v. confertissimis (deinde deplanatis) obsitus, gonidiis per totam partem instructus. Apothecia plura in singulis verrucis thalli inclusa (excipulo proprio prorsus nullo) primitus a thallo tecta, tandem aperta, discis irregularibus sæpe in pseudo-discum confluentibus, epithecio fusco, paraphysibus tenerrimis tortilibus. Sporæ 4næ simplices ellipsoideæ grumo-granulosæ dilute luteæ, episporio crasso, longit. ·082 mm., crassit. ·04 mm. Ad saxa.

Lecidea littoralis, Kn. (Plate XXXVII. fig. 3.)

Thallus cinereo-albidus v. cinerascens crassus continuus v. areolatus late expansus lævis. Apothecia adnata mujuscula (latit. 2·65 mm.) sparsa atra pruinosa tenuiter marginata dein tumidula et difformia, margine atro flexuoso v. lobato inciso. Sporæ simplices ellipsoideæ, longit. ·013 ad ·018 mm., crassit. ·006 mm. Hypothecium fuscum v. linea atra hypothecii latera et basin circumscribens. Ad saxa.

Lecidea subglobulata, Kn. (Plate XXXVII. fig. 4.)

Thallus cinerascens minute furfuraceo-diffractus v. squamuloso-areolatus, granulis gonimis viridibus. Apothecia immarginata interdum confluentia, disco atro convexo tandem hemisphærico v. subglobuloso. Sporæ in ascis ventricosiusculis simplices ellipsoideæ subhyalinæ tandem dilute luteæ, longit. ·013 mm. ad ·022 mm., crassit. ·007 mm. Hypothecium atrum v. fuscum. Ad saxa.

Lecidea subargillacea, Kn. (Plate XXXVII. fig. 5.)

Thallus luteo-albus continuus. Apothecia subaggregata innata v. adnata concava fusca immarginata interdum difformia sæpe furfuracea. Sporæ in ascis cylindraceis grumoso-luteæ v. hyalinæ longit. ·016 mm., crassit. ·008 mm. Hypothecium album. Ad terram argillaceam.

Syn. *Lecidea meiospora*, Nyl. (?).

LECIDEA ATRO-MORIO, Kn. (Plate XXXVII. fig. 6.)

Thallus nigro-cinerascens tenuis squamulosus, squamulis minutis rotundis planis rufescentibus nitidis ad ambitum plerumque minute furfuraceis. Apothecia atra parva plana ex hypothallo nigricante inter squamulas denudato oriunda, squamulas haud superantia, interdum margine thallino spurio granulis minutissimis cincta. Sporæ minutæ ovoideæ v. globosæ, longit. ·0065 mm., crassit. ·005 mm. Gonidia magna. Hypothecium fuscum. Ad saxa.

LECIDEA SUBLAPICIDA, Kn. (Plate XXXVII. fig. 7.)

Thallus granulosus indeterminatus cinereo-albus. Apothecia in thalli lacunis sæpissime confluentia adpressa aterrima nuda planiuscula v. concaviuscula, margine tenuissimo atro undulato, paraphysibus tenuibus conglutinatis. Sporæ in ascis ventricoso-clavatis parvulæ ovoideæ simplices hyalinæ longit. ·005 mm., crassit. ·004 mm. Stratum hypothecii subhymeniale atrum. Ad saxa.

Differs from *L. lapicida* in its smaller ovoid spores, much finer paraphyses, and black hypothecium. In *L. lapicida* the subhymenial stratum is slightly coloured, and the inferior stratum a thin black line continued from the margin.

LECIDEA NIGRESCENS, Kn.

Thallus nigro-cinerascens tenuis lævis indeterminatus. Apothecia atra minuta convexa emarginata, paraphysibus conglutinatis. Sporæ in ascis ventricoso-clavatis minutæ ovoideæ simplices hyalinæ longit. ·004 mm., crassit. ·003 mm. Stratum hypothecii subhymeniale atrum. Ad saxa.

LECIDEA SCHISTACEA, Kn. (Plate XXXVII. fig. 8.)

Thallus schistaceus determinatus tenuis squamulosus, squamulis rotundis adpressis minutissimis pruinosis hypothallo nigro. Apothecia nigra mediocria v. parva squamulas superantia marginata disco plano, margine prominente interdum undulato. Sporæ minutæ ellipsoideæ incolores, longit. ·008 mm., crassit. ·004 mm. Hypothecium nigrum. Ad saxa.

LECIDEA SUBCOARCTATA, Kn. (Plate XXXVII. fig. 9.)

Thallus cinereo-albus areolatus v. areolato-granulosus v. continuus. Apothecia conferta fusca v. atro-fusca adnata sat parva convexa, margine integerrimo pallido v. dilute fusco nudo demum evanido. Sporæ in ascis ventricoso-clavatis simplices ovoideæ incolores, longit. ·011 mm., crassit ·007 mm. Hypothecium album. Ad saxa.

Differs from *L. coarctata* in the much smaller ovoid spores, the ventricose ascus, and white hypothecium.

LECIDEA SUBBADIO-ATRA, Kn. (Plate XXXVII. fig. 10.)

Thallus fusco-cinereus rimulosus æqualis. Apothecia nigro-fusca convexa marginata, margine dilute concolori in statu juvenili prominente, demum obscurato. Sporæ

fuscæ oblongæ curvatulæ 1-septatæ, longit. ·025 mm., crassit. ·01 mm. Lamina prolifera ex hypothecio nigro duplici (strato intermedio fusco) enata. Ad saxa.

LECIDEA WHAKATIPÆ, Kn. (Plate XXXVII. fig. 11.)

Thallus albus parum visibilis v. obsolete indicatus. Apothecia parva atra, juniora plana et tenuiter marginata, dein convexa v. suborbiculata immarginata. Sporæ fuscæ ellipticæ longit. ·013 mm., crassit. ·006 mm. Hypothecium atrum.

LECIDEA STELLULATA, Tayl. (?)

Thallus albus v. cinereus tenuissimus minutissime areolatus v. granulosus hypothallo atro limitatus sæpius in agellos ab hypothallo denudato metatus. Apothecia parva subinnata confluentia atra plana tenuiter marginata, margine sæpe e granulis effusis. Sporæ in ascis ventricoso-clavatis ovatæ fuscæ 1-septatæ, longit. ·012 mm., crassit. ·006 mm. Hypothecium atrofuscum. Ad saxa.

LECIDEA SUBTUBULATA. (Plate XXXVII. fig. 12.)

Thallus *continuus fumosus* tenuissimus. Apothecia elevato-sessilia tenuiter marginata, disco plano, margine atro elevato. Sporæ in ascis clavatis *fuscæ* plerumque in medio constrictæ *nonnunquam loculis tubulo brevi junctis,* longit. ·017 mm., crassit. ·009 mm. Paraphyses distinctæ. Lamina proligera ex hypothecio *stramineo* enata ; *linea atra hypothecii latera et in parte basin circumscribens.* Ad saxa.

LECIDEA PETRÆA, Flot., var. NEO-ZELANDICA, Kn. (Plate XXXVII. fig. 13.)

Thallus cinereo-plumbeus minute granulosus, ex hypothallo nigricante inter granula denudato enatus. Apothecia sat parva plana crebra, disco aterrimo nudo elevato-marginato, margine primum e granulis minutis suffusis, tandem fusco-atro. Sporæ in ascis ventricosis 3–5-septatæ, et septa transversa septulis longitudinalibus v. obliquis juncta, subhyalinæ tandem dilute fuscæ, longit. ·023 mm., crassit. ·009 mm. Hypothecium fusco-nigrum. Ad saxa.

LECIDEA PETRÆA, Flot., var. VIOLACEA. (Plate XXXVII. fig. 14.)

Thallus minute tuberculosus, tubercula violacea, hypothallo nigricante. Apothecia parva creberrima nigra innata v. adnata concaviuscula immarginata. Sporæ fuscæ 5-septatæ, septa transversa septulis longitudinalibus v. obliquis juncta, longit. ·027 mm., crassit. ·01 mm. Hypothecium atrum.

LECIDEA TUBULATA, Kn. (Plate XXXVII. fig. 15.)

Thallus granuloso-diffractus albo-cinerascens indeterminatus. Apothecia nigro marginata, disco plano pruinoso, margine atro elevato. Sporæ in ascis clavatis fuscæ biloculares, loculis tubulo brevi junctis, longit. ·018 mm., crassit. ·011 mm. Hypothecium atrum. Hypothallus albus. Ad saxa.

LECIDEA SUBFARINOSA, Kn. (Plate XXXVII. fig. 16.)

Thallus albus effusus rugulosus. Apothecia (latit. 8 mm. v. minora) albo-pruinosa rotun-

dato-difformia elevato-sessilia tenuiter marginata, margine sæpe flexuoso, paraphysibus superne fuscescentibus concretis, disco concavo vel plano vel convexo. Sporæ 4–6-septatæ aciculari-fusiformes incolores vel tandem dilute lutescentes, longit. ·034 mm., crassit. ·005 mm.

Ad cortices arborum.

L. farinosa, Ach., *L. Dillemana*, Ach., *L. abietina*, Ach., *L. premnea*, Ach., and the above-described Lichen are very closely allied. The New-Zealand Lichen approaches closely *L. abietina*, Ach., from which it differs principally in the greater number of septa, in the spores, and the smaller apothecia.

THELOTREMA SAXATILE, Kn. (Plate XXXVII. fig. 17.)

Thallus albidus v. cinereo-albidus continuus granulosus indeterminatus tenuis. Apothecia normaliter globosa in verrucis thallinis rotundatis supra planis immersa, aperturis rotundatis depressis, excipulo proprio instructa, paraphysibus capillaribus. Ascus monosporus. Sporæ dilute fuscæ tandem fusco-nigricantes fusiformes murali-divisæ, longit. ·16 mm., crassit. ·038 mm. Ad saxa.

THELOTREMA MONOSPORUM, var. PATULUM, Kn. (Plate XXXVII. fig. 18.)

Thallus luteo-albus rimoso-diffractus crassus. Apothecia verrucæformia excipulo duplici instructa, interiore membranaceo tandem lacero-dehiscente, nucleo madefacto expanso discoideo. Ascus monosporus interdum disporus (unde sporis minoribus). Sporæ fuscæ fusiformes murali-divisæ, longit. ·05 ad ·1 mm., crassit. ·015 ad ·03 mm. Ad cortices arborum.

Syn. *Thelotrema monosporum*, var. *patulum*, Nyl. in litt.

ASTROTHELIUM PYRENASTROIDES, Kn. (Plate XXXVII. fig. 19.)

Thallus effusus glauco-ochraceus v. cinereo-albescens v. olivaceus rimulosus. Apothecia convexa a thallo plus minus velata demum denudata carbonacea, loculis 2–5, ostiolis convergentibus in os commune sæpissime desinentibus, ore ochraceo, paraphysibus tenerrimis rectis v. subtortilibus. Sporæ in ascis elongato-cylindraceis incolores demum dilute fuscæ fusiformes 5–8-septatæ (vix unquam 3–4-septatæ) v. sæpius murali-divisæ v. interdum locellis medianis a septulis longitudinalibus divisis, longit. ·038 mm., crassit. ·012 mm. Ad cortices arborum.

Syn. *Verrucaria pyrenastroides*, Kn., Trans. Linn. Soc. vol. xxiii. p. 100, tab. ii.; *Astrothelium prostratum*, Stirton, Journ. Linn. Soc. vol. xiv. p. 473; *A. ochrocleistum*, Nyl., in litt. An *Trypethelium pyrenuloides*, Mont.?, *T. Cumingii*, Fee?, *T. astroidea*, Fee?, *Verrucaria Thwaitsii*, Leight.?

VERRUCARIA GEMELLIPARA, Kn. (Plate XXXVII. fig. 20.)

Thallus flavo-æneus v. flavo-olivaceus tenuissimus glaber linea nigra limitatus. Apothecia parva parum prominula, ambitu applanato, dimidiatim nigra, basi amplificata, poro pertuso instructa, paraphysibus distinctis. Sporæ obovatæ uniseptatæ sæpe in

medio subconstrictæ cellula superiore majore incolores, longit. ·017 mm., crassit. ·006 mm. Ad cortices arborum.

Syn. *Verrucaria circumpressa*, Nyl., in litt.; *V. epidermidis*, var. *gemellipara*, Kn.

VERRUCARIA MINUTISSIMA, Kn. (Plate XXXVII. fig. 21.)

Thallus atro-cinerascens tenuissimus. Apothecia contigua minutissima prominula dimidiatim nigra poro pertuso instructa, paraphysibus distinctis. Sporæ dilute fuscæ uniseptatæ (an interdum 3-septatæ?) in medio subconstrictæ, cellula superiore majore, longit. ·018 mm., crassit. ·005 mm. Ad cortices arborum.

The spores have much the appearance of a *Sphæria*; except the bright colour, not unlike those of *Verrucaria conferta*, Tayl. (Leight. Angioc. Lich.).

VERRUCARIA SUBBIFORMIS, Kn. (Plate XXXVII. fig. 22.)

Thallus albus effusus inæqualis rimosus. Apothecia subminuta prominentia (madefacta innata) nigra subglobosa integra, paraphysibus capillaribus confertis. Sporæ in ascis cylindraceis oblongæ 1-septatæ incolores, longit. ·02 mm., crassit. ·007 mm. Ad cortices arborum.

BAGGLIETTOA, Mass. (?), OCELLATA, Kn. (Plate XXXVII. fig. 23.)

Thallus fusco-cinereus continuus tenuis subglaber, gonidia magna. Apothecia in verrucis prominulis immersa interdum 2–4 confluentia, excipulo proprio carbonaceo instructa, primo punctiformia dein aperta, margine thallino albo sculpto-angulari v. sculpto-subrotundo v. irregulariter dehiscente. Nucleus globosus verrucoideus, amphithecio grumoso oriundus, paraphysibus crassis mucoso-diffluxis farctus. Sporæ in ascis curvatulis fusiformibus ellipsoideæ incolores v. luteo-grumosæ, longit. ·028 mm., crassit. ·012 mm. Ad saxa.

VERRUCARIA OCCULTA, Kn. (Plate XXXVII. fig. 24.)

Thallus crustaceus lævigatus aureus v. ochraceus v. ochraceo-albus verrucoso-colliculosus irregulariter plicato-rugulosus plus minus rimosus. Apothecia numerosissima globosa in verrucis thalli confluentibus penitus abdita, ab excipulo simplici proprio carbonaceo clausa, canaliculis ad sporas mittendas in verrucas thalli productis, ostiolis paululum depressis minutis instructa, paraphysibus distinctis capillaribus. Sporæ in ascis elongato-cylindraceis oblongo-ovoideæ 3-septatæ dilute fuscæ v. subincolores longit. ·016 mm., crassit. ·006 mm. Ad cortices arborum.

An *V. micromma*, Mont.?

VERRUCARIA PRUINO-GRISEA, Kn. (Plate XXXVII. fig. 25.)

Thallus effusus tenuis plus minus pseudo-farinaceus griseus. Apothecia minutissima dimidiata patentia. Sporæ in ascis clavatis incolores tandem fuscæ lineari-oblongæ 1-septatæ v. sæpissime interrupte quadrinucleolatæ, longit. ·02 mm., crassit. ·006 mm. Ad cortices arborum.

Verrucaria dealbata, Kn. (Plate XXXVIII. fig. 1.)

Thallus albescens tenuis effusus glaber. Apothecia nigra parva hemisphærico-conoidea dimidiata, paraphysibus distinctis. Sporæ in ascis cylindraceis dilute fuscæ ellipsoideæ 3–5-septatæ, longit. ·023 mm., crassit. ·008 mm. Ad cortices arborum.

Verrucaria saxicola, Kn. (Plate XXXVIII. fig. 2.)

Thallus luteo-olivaceus tenuissimus v. nullus. Apothecia parvula hemisphærica, perithecio carbonaceo integro, ostiolo inconspicuo, nucleo subgloboso hyalino, paraphysibus capillaribus farcto. Sporæ in ascis elongato-cylindraceis incolores fusiformes 7–8-septatæ, longit. ·032 mm., crassit. ·005 mm. Ad saxa.

Verrucaria astata, Kn. (Plate XXXVIII. fig. 3.)

Thallus tenuis fulvo-fuscus v. cinereo-fuscus opacus continuus indeterminatus. Apothecia nigra prominula (madefacta sæpe innata) hemisphærica integra, paraphysibus capillaribus tenerrimis distinctis. Sporæ in ascis elongato-cylindraceis ovoideæ fuscæ 3-septatæ, longit. ·04 mm., crassit. ·009 mm. Ad cortices arborum.

Probably this may be *V. aspistea*, Ach.; but there is much confusion about Acharius's plant. Nylander remarks "Esse videtur modo *V. nitida* minor, sporis minoribus." Montagne describes *V. aspistea*, Ach., "sporis magnis ellipticis 16-annulatis, annulis pauci-cellulosis;" he adds that *V. aspistea* of Eschweiler is incorrectly named, and he has therefore named Eschweiler's plant *V. Eschweileri* with "spora binucleolata." Acharius describes his Lichen as having a polished yellowish thallus, limited by a black line, in these and other characters differing from the New-Zealand Lichen.

Porina endochrysa, Mont. (Plate XXXVIII. fig. 4.)

Thallus late effusus tenuis fragilis colliculosis glauco-cinereus subtus bullatus. Apothecia immersa, perithecio flavescente integro normaliter globoso, ostiolo fusco depresso primum occluso demum aperto, nucleo fusco, paraphysibus filiformibus. Sporæ 8næ incolores cymbiformes murali-divisæ, longit. ·09 ad ·15 mm., crassit. ·025 ad ·04 mm., episporio crasso. Ad cortices arborum.

Syn. *Thelenella wellingtonii*, Stirton, Journ. Linn. Soc. vol. xiv. p. 473.

Chiodecton (Platygrapha) inconspicuum, Kn. & Mitt. (Plate XXXVIII. fig. 5.)

Thallus crustaceus cinereo-violaceus verrucæformis, verrucis dilute concoloribus. Apothecia minuta normaliter globosa, in verrucis thallinis rotundatis v. flexuoso-elongatis supra planiusculis immersa (passim confluentia) plura in quavis verruca unumquidque ex atro-fusco toro oriens, disco rotundo v. oblongo v. attenuato-oblongo nigro. Sporæ oblongo-fusiformes curvatulæ 3-septatæ incolores, longit. ·05 mm., crassit. ·004 mm. Ad cortices arborum.

Syn. *Chiodecton conchyliatum*, Stirton; *C. moniliatum*, Stirt.; *C. sinuosum*, Stirt.

Opegrapha saxicola, Ach. (Plate XXXVIII. fig. 6.)

Thallus obliteratus. Apothecia atra lirellæformia sæpe flexuosa rarius rotundo-difformia,

epithecio pliciformi v. rimæformi, marginibus parallelis v. medio paullulum distentis. Sporæ lineari-oblongæ v. lineari-clavatæ 3-septatæ dilute luteæ, longit. ·017 mm., crassit. ·006 mm. Ad saxa.

FISSURINA NOVÆ-ZELANDIÆ, Kn. (Plate XXXVIII. fig. 7.)

Thallus crustaceus lævigatus ochraceus tenuiter areolatus. Apothecia immersa flexuosa lineari-elongata, fissuris a thallo marginatis conniventibus tumidulis, excipulo atro-fusco crasso a thallo insuper tecto infra subito evanescente. Sporæ in ascis clavatis 5-septatæ ellipsoideæ incolores, longit. ·02 mm., crassit. ·01 mm. Ad saxa.

MELASPILEA METABOLA, Nyl. (Lich. Novæ Caledoniæ). (Plate XXXVIII. fig. 8.)

Thallus cinereo-albidus v. cinereus diffracto-rimosus v. areolatus, tenuissimus. Apothecia nigra v. fusca parva rotundato-lecideoidea (juniora punctiformia) convexa immarginata, intus pallido-incoloria. Sporæ 2–8næ oblongo cylindraceæ inferne magis attenuatæ et curvatulæ (sæpe in capillam productæ) murali-divisæ v. multiloculares, longit. 0·075 ad 0·1 mm., crassit. 0·01 mm. Thecæ pyriformes infra in caudam nonnihil flexuosam productæ. Hypothecium dilute fuscescens.

Syn. *Melaspilea amphorodes,* Stirton.

PHLYCTIS SORDIDA, sp. nov. (Plate XXXVIII. fig. 9.)

Thallus cinereus fragilis tenuis v. crassus contiguus subgranulosus inæqualis v. corrugato-rimosus v. minutissime areolatus. Apothecia minuta rotundato-difformia, margine thallino albino-leproso cincta, disco fusco nonnihil farinoso. Sporæ 5–8-septatæ ellipsoideæ curvatæ incolores, longit. 0·06 mm., crassit. 0·007 mm. Ad corticem.

Obs. When the thallus is thin it necessarily adapts itself to the surface on which it grows, and may thus be either smooth, rugose, rimose, &c.

PHLYCTIS OCELLATA, sp. nov. (Plate XXXVIII. fig. 10.)

Thallus albido-canescens v. dilute murinus fragilis corrugato-rimosus. Apothecia minuta regularia in tuberculo innata, a thallo marginata, nucleo strato gonimo imposito, disco fusco concaviusculo. Sporæ ellipsoideæ incolores 3–6-septatæ, longit. 0·028 mm., crassit. 0·004 mm. Ad corticem.

PHLYCTIS NEO-ZELANDIÆ, sp. nov. (Plate XXXVIII. figs. 11 & 12.)

Thallus albus crassus v. tenuis rimosus fragilis lævis v. granulosus. Apothecia minuta solitaria v. aggregata innata rotundato-difformia a thallo pruinoso velata vel margine thallino albido-leproso cincta, disco dilute fusco albido-pruinoso. Sporæ in ascis obovato-clavatis normaliter 8næ curvatæ cylindraceo-ellipsoideæ, apicibus acutis v. obtusis dilute flavescentes 6–9-septatæ, longit. 0·07 mm., crassit. 0·006 mm. Paraphyses distinctæ. Ad corticem.

Obs. There is a variety with thin white granular thallus; spores cylindrical, rounded at either apex.

STICTA CANALICULATA, sp. nov.

Thallus glauco-pallescens late expansus (latit. usque pedalis) rigens vix nitidiusculus lævis lineari-laciniatus canaliculatis, laciniis insignius sinuato-pinnatifidis, subtus totus tomentosus luteo-fuscescens, cyphellæ albidæ suburceolatæ mediocres v. majusculæ. Apothecia badio-rufa v. fusca (latit. 5 mm.) margine crenulato, receptaculo granulato. Sporæ leviter fuscescentes fusiformi-oblongæ uniseptatæ, longit. 0·025 mm., crassit. 0·01 mm.

Obs. Much stouter than *S. variabilis*, and differs from *S. damæcornis* in the white larger cyphellæ, the channelled laciniæ, and the under surface entirely covered by a brown tomentum.

PLACODIUM ILLITUM, sp. nov. (Plate XXXVIII. fig. 13.)

Thallus contiguus *determinatus* fusco-cinerascens v. sordide albus arcte adnatus *lævis* v. in centro minute granulosus in ambitu *non radioso-sublobatus sed minutissime crenatus* gonimicus sæpe cephalodiis fusco-luteis radiatim onustus. Apothecia crebra v. conferta unde per mutuam pressionem tandem difformia, margine cinerascente v. albo *subinde evanescente,* disco *fusco-nigrescente* concavo per ætatem plano et marginem subæquante. Paraphyses discretæ. Sporæ in ascis elongato-cylindraceis uniserialiter octonæ luteæ ellipsoideæ, longit. ·012 mm., crassit. ·007 mm. *Hypothallus fuscus.* Ad lapides.

Differs from *P. gelidum,* Ach., in the darker non-lobate thallus, in the colour of the disk, and the thinner margin of the apothecia, and the dark brown hypothallus. *P. Rhuderi* has an albido-lutescent and lobate thallus, the disk of the apothecia atro-pruinose, and the spores not exceeding ·008 mm. in length.

PLACODIUM ARGILLACEUM, sp. nov. (Plate XXXVIII. fig. 14.)

Thallus cinereo-albus farinaceus *polline albo obsitus continuus indeterminatus.* Cephalodia carnea centrali radiatim rimosa. Apothecia urceolata disco *carneo,* margine *crasso* albo *farinaceo.* Sporæ in ascis elongato-cylindraceis uniserialiter octonæ ellipsoideæ, longit. ·016 mm., crassit. ·008 mm. Supra terram.

PLACODIUM LECANORINUM, sp. nov. (Plate XXXVIII. fig. 15.)

Thallus albido-cinerascens *continuus determinatus* arcte adnatus tenuis lævis v. subgranulato-pulverascens. Cephalodia copiosa *fusca* v. *fusco-atra* madefacta indistincte radiatim rugosa. Apothecia sordide carnea concava, margine albido interdum farinaceo, paraphysibus distinctis. Sporæ in ascis elongato-clavatis *obovatæ 3-septatæ,* longit. ·018 mm., crassit. ·006 mm., hyalinæ v. pallide luteæ. *Hypothallus pallide fulvus.* Ad lapides.

EXPLANATION OF THE PLATES.

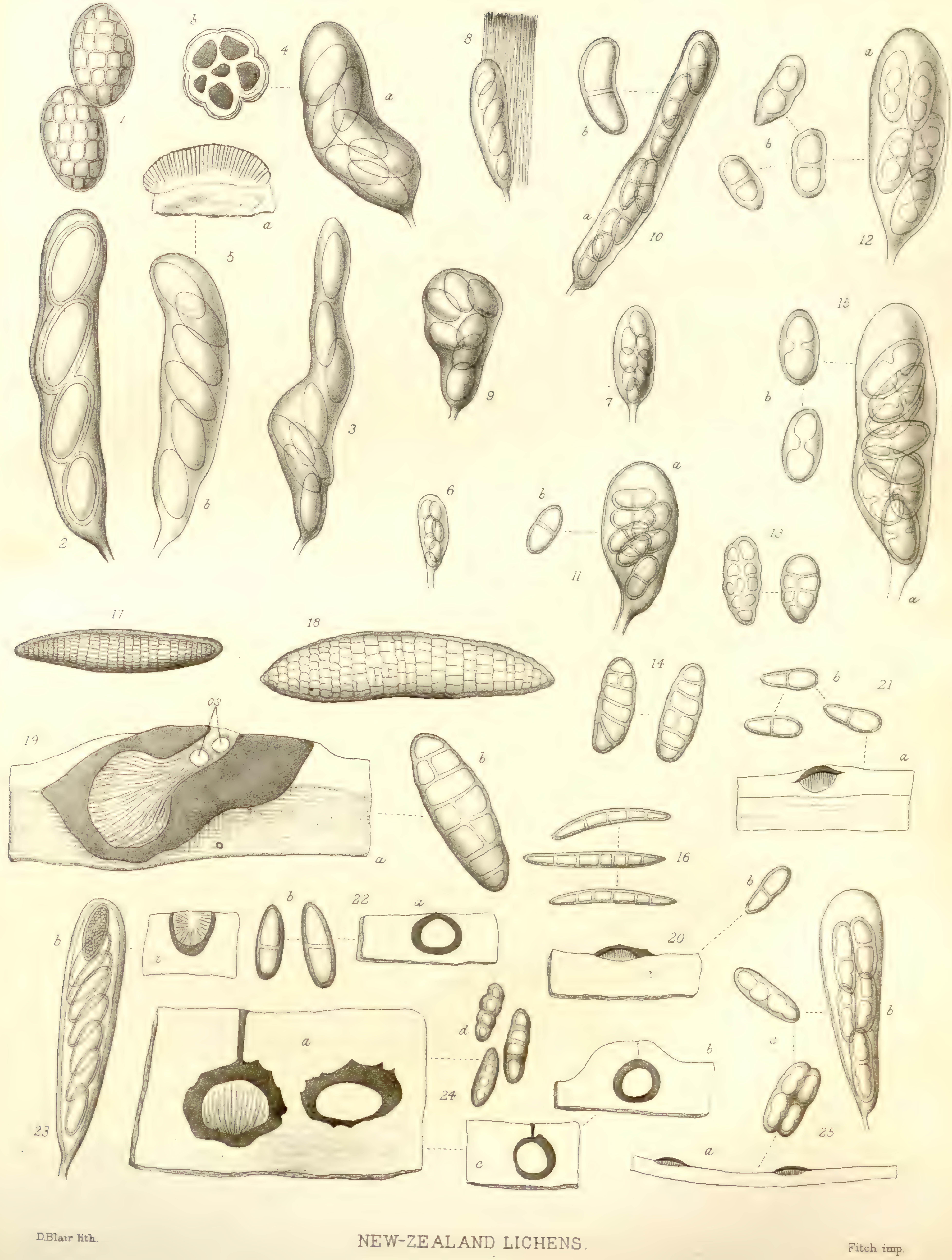
[The whole of the figures in these Plates have been greatly magnified; but in his MS. the author has omitted to add the degree of enlargement of each object.—EDITOR.]

PLATE XXXVII.

Fig. 1. Spores of *Urceolaria Novæ-Zelandiæ*.
Fig. 2. Ascus of *Pertusaria graphica*.
Fig. 3. Ascus of *Lecidea littoralis*.
Fig. 4. *L. subglobulata*. *a*. Ascus with spores; *b*. Squamule with apothecia.
Fig. 5. *L. subargillacea*. *a*. Section of apothecium; *b*. Its ascus.
Fig. 6. Ascus of *L. atro-morio*.
Fig. 7. Ascus of *L. sublapicida*.
Fig. 8. Ascus of *L. schistacea*.
Fig. 9. Ascus of *L. subcoarctata*.
Fig. 10. *L. subbadio-atra*. *a*. Ascus; *b*. A separate spore.
Fig. 11. *L. Whakatipæ*. *a*. Ascus; *b*. A single spore.
Fig. 12. *L. subtubulata*. *a*. Ascus; *b*. Spores in different stages.
Fig. 13. Spores of *L. petræa*, var. *Neo-Zelandica*, in different stages.
Fig. 14. Spores of *L. petræa*, var. *violacea*.
Fig. 15. *L. tubulata*. *a*. Ascus; *b*. Separate spores.
Fig. 16. Spores of *L. subfarinosa*.
Fig. 17. A spore of *Thelotrema saxatile*.
Fig. 18. A spore of *T. monospermum*, var. *patulum*.
Fig. 19. *Astrothelium pyrenastroides*. *a*. Section of apothecium, showing at *os* the ostioles of adjoining cells opening into common canal; *b*. A spore of same lichen.
Fig. 20. *Verrucaria gemellipara*. *a*. Apothecium in section; *b*. A spore.
Fig. 21. *V. minutissima*. *a*. Apothecium in section; *b*. Spores of same.
Fig. 22. *V. subbiformis*. *a*. Section of apothecium; *b*. Spores.
Fig. 23. *Baggliettoa*, Mass.?, *ocellata*, Kn. *a*. Apothecium in section; *b*. Ascus of same lichen.
Fig. 24. *Verrucaria occulta*. *a, b, c*. Various sections of apothecia; *d*. Spores of same lichen.
Fig. 25. *V. pruino-grisea*. *a*. Section of apothecia; *b*. An ascus; *c*. Spores in different stages.

PLATE XXXVIII.

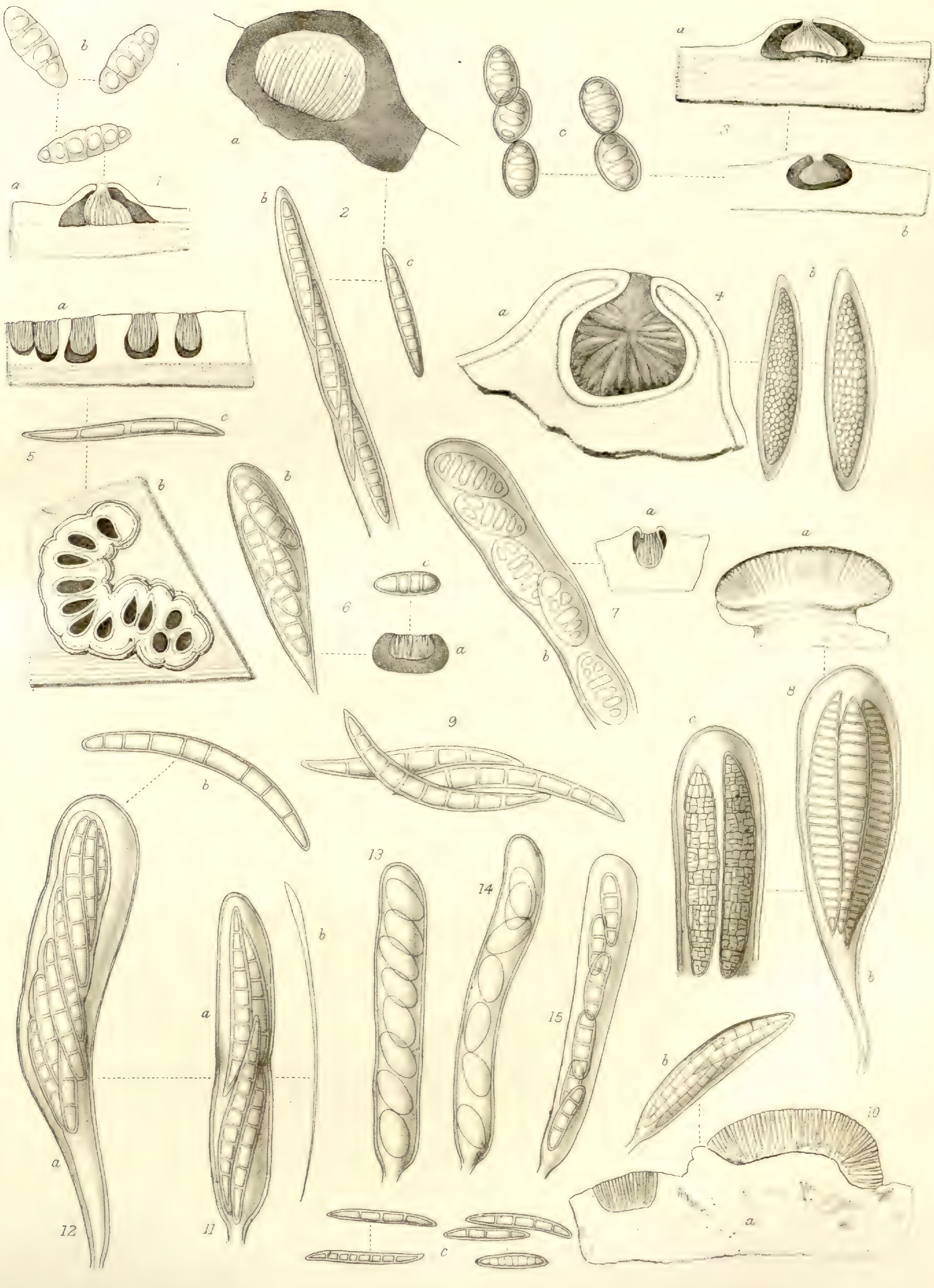
Fig. 1. *Verrucaria dealbata*. *a*. Apothecium in section; *b*. Spores.
Fig. 2. *V. saxicola*. *a*. Apothecium in section; *b*. Ascus; *c*. A spore.
Fig. 3. *V. astata*. *a, b*. Sections of apothecia; *c*. Spores.
Fig. 4. *Porina endochrysa*. *a*. Apothecium in section; *b*. Two spores.
Fig. 5. *Chiodecton* (*Platygrapha*) *inconspicuum*. *a*. Vertical section, displaying several apothecia; *b*. Horizontal section of same; *c*. A septate spore.
Fig. 6. *Opegrapha saxicola*. *a*. Section of apothecium; *b*. Ascus; *c*. Spore.
Fig. 7. *Fissurina Novæ-Zelandiæ*. *a*. Apothecium in section; *b*. Portion of ascus.
Fig. 8. *Melaspilea metabola*. *a*. Section of apothecium; *b*. Ascus; *c*. Upper portion of ascus.
Fig. 9. *Phlyctis sordida*, its separate spores.
Fig. 10. *P. ocellata*. *a*. Two apothecia in section. *b*. Ascus; *c*. Five separated spores.
Fig. 11. *P. Neo-Zelandiæ*. *a*. Ascus; *b*. A paraphysis.
Fig. 12. *P. Neo-Zelandiæ*, var. *a*. An ascus; *b*. Septate spore of same.
Fig. 13. Ascus of *Placodium illitum*.
Fig. 14. Ascus of *P. argillaceum*.
Fig. 15. Ascus of *P. lecanorinum*.



D.Blair lith.

NEW-ZEALAND LICHENS.

Fitch imp.



D. Blair lith.

NEW-ZEALAND LICHENS.

Fitch imp

XIX. *On some Points in the Morphology of the Primulaceæ.* *By* M. T. Masters, *M.D., F.R.S., F.L.S., &c.*

(Plates XXXIX.–XLI.)

Read June 7th, 1877.

THE most generally interesting points connected with the structure of the flowers of the Primulaceæ reside in the superposition of the stamens to the petals, the free central placenta, and the nature of the ovules.

Much discussion has taken place with reference to all these points. The explanation of the observed facts, and the arguments and inferences based upon them, have been derived from a study—

1. Of the comparative morphology of the genera of the order and of its allies.
2. Of the mode of development or organogenesis of the parts of the flower.
3. Of the minute anatomy of the flowers, and especially of the distribution of the vascular bundles within them.
4. Of the teratological phenomena observed in the order.

These latter are exceedingly numerous, and have consequently attracted the attention of a proportionate number of observers. It is to them that I propose to devote much attention in this paper, though I would deprecate the notion that teratological changes *per se* are to be taken as safe guides to the explanation of structure. The evidence they afford always requires to be controlled by that derived from other sources.

I must preface my remarks by stating that I have personally examined during the last twenty years a very large number of such instances, while my note-book teems with references to what has been published by others in this country and abroad.

It would be hardly possible to cite all these references, and certainly not desirable to do so; for many of them are, relatively speaking, of little importance to the matters I propose now to bring under the consideration of the Society. Such, for instance, are the malformations affecting the stem, leaves, or inflorescence, phenomena interesting in themselves, but which throw no special light on the structure of the order.

In passing, I may make allusion to the very great frequency with which deviations from the usual or, as it is called, typical structure occur in this group. As is well known to all who pay attention to these matters, malformations are much more common in some orders than in others. In the case of Primulaceæ a glance at the recorded literature will suffice to show how unstable, if I may so say, is the structure of certain genera of this order. Were it possible to enumerate individual cases, the fact would be even more prominently noticeable.

From the frequency with which these changes occur in such genera as *Primula* and *Cyclamen* it might be inferred that the changes induced by cultivation afforded sufficient reason for these structural aberrations. No doubt this is to a certain extent true. But

even among wild plants not subjected to cultivation the relative proportion of variously deformed Primulaceæ is decidedly large.

The common Primrose is, for instance, very subject to such changes, while the species of *Lysimachia* and *Anagallis,* which are comparatively rare in gardens, are so in a less degree.

Particular genera and even particular species are much more subject to these changes than others—the wild Primrose, for instance, as compared with the wild Cowslip. So in cultivation *Primula prænitens* (*P. sinensis*) is exceedingly liable to morphological disturbances, while *Primula cortusoides* and *P. japonica* are at present, according to my experience, but very slightly so.

It may be said, perhaps, that the varying conditions under which wild plants of widely extended geographical distribution grow may have some effect in determining these changes; but if so, they are not very obvious; for one may find a single patch of malformed Primroses growing amid a multitude of normal flowers, and apparently under like conditions. *Samolus Valerandi* has almost world-wide distribution; but it grows everywhere in similar localities; hence it is not surprising to find that, comparatively speaking, this species is not much subject to monstrous deviations from the typical structure. It is worthy of consideration whether this instability of form in certain species is connected with any change, either in the way of advance or retrogression—whether, in other words, it is in any way connected with the progressive development of an advancing type, or the gradual degeneration of a form destined to more or less speedy extinction. This, however, is a question upon which it is not my purpose to enter in this place.

I propose now to glance briefly at some of the more important changes which are met with in the plants of this order.

Calyx.—The most frequent deviations from the normal type of calyx consist in an enhanced degree of leafy development, or *phyllody*—a very common occurrence in the Chinese Primrose of gardens (*Primula prænitens*), and by no means uncommon in wild Primroses.

Sometimes the leafy character is associated with complete *dialysis* of the sepals, when there results a calyx of five free leaves, sometimes distinctly petiolate, as in the *Cyclamen* figured on the next page*. A minor degree of this change, that called "*virescence*," is also not uncommon. Here the parts of the flower are nearly unchanged in form and position, but are of a green colour.

A change of an opposite character is that wherein the calyx assumes the coloration of the corolla, the condition called "*calycanthemy*." This occurs in some long-cultivated varieties of Polyanthus, and has been made the subject of a special memoir by the late Prof. Morren †.

Corolla.—The teratological changes which occur in the corolla of Primulaceæ are of special interest in connexion with the notions entertained by morphologists as to its constitution. In most of the genera of the order the five petals of which the corolla consists form, at the base, a tube of varying length and diverse form, while above the five

* Masters, 'Vegetable Teratology,' p. 248.

† Bull. Acad. Belg. xix. part 2, p. 93.

segments are free. Attached to the corolla-tube, and superposed to its segments, are the five stamens.

In *Glaux* the corolla is wanting. In *Samolus* five scales emerge from the throat of the corolla, alternating with the stamens, which naturally suggests the notion that they represent an outer row of stamens, which in most cases is suppressed*. In a double-flowered *Cyclamen*† lately examined by me there was a double row of petals, the inner occupying the position of the scales of *Samolus*.

Others consider that the petal and the stamen are in this case not two distinct parts but two divisions of the same part. Thus Duchartre‡ describes the petals as appearing after the stamens as a sort of appendage or *dédoublement*:—"Elle (the corolla) ne constitue en effet dans l'origine qu'un bourrelet ou un petit repli qui entoure la base du verticille staminal." Van Tieghem §, basing his opinion on the fact that a common fibro-vascular bundle divides into an outer and an inner division, the former for the petal, the latter for the stamen, comes to the conclusion that stamen and petal form part of the same phyllome.

Cyclamen with leafy calyx, referred to in the text.

A similar conclusion is arrived at by Pfeffer ‖ from the study of the development of the flower. He shows that within the calyx five small tubercles are developed, alternating with the sepals. Each of these tubercles ultimately develops into a stamen; and from the outer surface of this stamen is gradually protruded the petal. According to this view, then, the Primrose has, morphologically, no corolla, the petals being merely outgrowths from the stamens ¶.

Development of the Parts of the Flower.—My own observations on the development of the flowers of *Primula* and *Lysimachia* lead me to a slightly different conclusion. In the first place, the mode of development does not appear to be uniform in the same genus; thus in some specimens of *Lysimachia nummularia* it has appeared to me that the petals did really sometimes (but not always) precede the stamens in their development. When this happens the latter advance so much more rapidly that they speedily outstrip the petals, and appear as if they had preceded them. If this be really so, the petal, instead of being an outgrowth from the stamen, is, in such cases, the organ from which the latter proceeds (Plate XXXIX. figs. 10–23). Many double Primroses, in which petal succeeds petal, one in front of another, the inner bearing a stamen, support this view.

In normal Primroses the course of development, according to my observation, is as

* Eichler, Blüthen-Diagramme, p. 327.

† 'Gardener's Chronicle,' March 17, 1877.

‡ Ann. Sc. Nat. 1844, ii. p. 279.

§ Ann. Sc. Nat. 1867, ix. p. 135.

‖ Pringsheim, Jahrbuch für wissensch. Botan. 1871, viii. p. 194.

¶ Frank (in Jahrbuch, 1875, t. x. p. 204) also says that the petalline tubercles are at first not distinct from the stamens.

follows:—The rounded end of the receptacle gives off first of all five sepals in successive order. These attain relatively considerable dimensions before the five staminal tubercles which come next in order are simultaneously protruded (Pl. XXXIX. fig. 1) and alternately with the sepals (Pl. XXXIX. fig. 2). After the staminal tubercles have advanced somewhat—after, indeed, the antheral portion is separated from the filament, the tubercles which are to form the petals are protruded apparently from the back of the filament (Pl. XXXIX. figs. 3, 4). I say apparently, because what really takes place (in *Primula*) is this. After the formation of the staminal tubercles the thalamus pushes out the petalline tubercles, one at the very base of the outer surface of each of the filaments, and so close to it that it seems to arise from the filament itself; the receptacle, continuing to grow in the form of a tube (Pl. XXXIX. fig. 4), upraises the corolla-tube, and with it the stamens. While this is taking place the extreme apex of the receptacle is pentagonal and tabular in appearance, or slightly depressed in the centre (Pl. XXXIX. fig. 2). On its raised edge five small tubercles sometimes appear simultaneously, which are the carpels (Pl. XXXIX. fig. 5). These five tubercles are gradually raised from below by the lengthening of the receptacle in a tubular manner (Pl. XXXIX. fig. 6), so that we have soon a flask-shaped pistil with a narrow neck and open mouth (figs. 7 & 8). Within the rudimentary pistil so sketched out the receptacle changes its former flat or depressed condition for a convex or dome-shaped appearance; the middle portion of this dome speedily becomes covered with ovules from above downwards; the upper portion elongates into a naked cone; and the lower portion forms a stipes, which is apparently quite free from the walls of the pistil. Fig. 9 shows a plan of a vertical section through the flower at this stage. The neck of the pistil gradually lengthens into a style, becomes closed; and so we have ultimately the perfect ovary, with whose appearance every one is familiar *.

Chorisis.—Adverting now to the teratological appearances presented by the individual petals, it may be mentioned that the petals of Primulaceæ are frequently the subjects of *lateral chorisis* or fission. Slight instances of this are seen in the petals of the common Primrose, in the central notch by which they are characterized. If this subdivision be carried further we may have deeply bipartite petals, or fringed ones, as in *Soldanella*; and if the process be carried to an extreme, we have ten petals in the place of five, as is not uncommon in Primroses and *Cyclamen* † (Pl. XXXIX. fig. 10). This lateral branching of individual petals must not be confounded with the *dialysis* or complete separation of one petal from another, which has been observed in the flowers of *Anagallis* ‡ and other genera, and which is the normal condition in the genera *Asterolinum* and *Apochoris*.

Enation, or outgrowth from the surface of the petals, is a process scarcely distinguishable from transverse chorisis except by the later period at which it occurs. Chorisis, as I understand it, is a congenital process, beginning with the growth and continuing

* Quite as frequently, as far as I have observed in *Lysimachia* and *Primula*, the pistil originates as a ring, which grows upward from beneath so as to form a tube, upon whose edge the five tubercles are not formed till quite late in development, and in some cases, especially in monstrous flowers, not at all (Pl. XL. fig. 4).

† 'Vegetable Teratology,' p. 359.

‡ *L. c.* p. 73.

with the development of the organ affected (unless arrested), whereas enation does not show itself for some time after the origination of the part. Chorisis is a true subdivision of the original organ. Enation is a secondary process, and is, as its name implies, an outgrowth from an organ already advanced some stages in development. Such outgrowths are of frequent occurrence in Primroses; and they have especial significance with reference to the mode of formation of the stamens, before alluded to (Pl. XXXIX. figs. 2 & 3), and also to the formation of the placenta. It is curious to observe that in some of these cases the dorsal face of the outgrowth is applied to the upper surface of the petal from which it springs, just as the leaves of a book follow one another in parallel order, as in the diagram, where the thick line represents the outer surface of the petals, and the thin lines the inner surface respectively , while in other cases the upper surfaces are placed opposite one another, thus *. In the latter case it sometimes happens that the margins of the outgrowth adhere to those of the original petal, and a tube is formed. It must be understood that there is no real change of position in this latter case, such as could only be brought about by a twisting of the lower part of the outgrowth, but that the cellular structure characteristic of the outer surface is developed on the inner surface, and *vice versâ*.

A *tubular* or *cupped* condition of the *petals* is one of the commonest deviations in *Primula prœnitens* †, the Chinese Primrose of gardens. It usually arises by a process of growth similar to that by which peltate leaves are formed; and as the marginal portions grow faster or more vigorously than the central ones, a cup or tube is eventually formed. In other cases the tube appears to be developed by the gradual incurvation and ultimate cohesion of the margins. It is possible that this latter condition represents the formation of the anther-lobes.

Adverting now to the principal malformations affecting the corolla of Primulaceæ as a whole, mention may be made of that general leafy condition known as phyllody or chloranthy, and which is frequently accompanied by prolification ‡. These changes will be incidentally referred to in the sequel. Another very common change consists in the duplication of the corolla. A "hose-in-hose" corolla is thus formed §. In such cases the petals of the inner corolla generally alternate with those of the outer; and then their autonomy may be safely assumed: but in other cases they are superposed; and then they are probably the result of enation, as before explained.

Andrœcium.—The commonest changes to which the stamens of Primulaceæ are subjected are various degrees of leafy or petaloid mutation, phyllody or petalody, as the case may be, such as have just been referred to, and, more rarely, of detachment from the tube of the corolla ‖.

Enation.—When what should be a stamen assumes a leafy or a petaloid condition it very often becomes subject to chorisis or to enation, in the same manner as in the

* Mast. in Journ. Roy. Hort. Soc. 1866, vol. i. new ser. p. 202; Veg. Teratology, pp. 377, 449.

† Veg. Terat. p. 315.

‡ See Marchand, Adansonia, 1864, p. 150; Baillon, Ann. Sc. Nat. sér. 3. t. 2, p. 290; Adansonia, iii. t. iv.; Bureau, Bull. Soc. Bot. Fr. x. p. 191.

§ Vegetable Teratology, p. 377.

‖ Ibid. p. 253.

case of the petals just referred to. (Pl. XXXIX. figs. 19 to 23 show illustrations of this character from a variety of Polyanthus known in gardens as the "Nigger.") In some of these cases enation takes place from both surfaces of the leafy or petaloid stamen (fig. 22), as may be illustrated thus , the central line indicating the axis of the staminode, the lateral ones the position of the outgrowth.

In some cases the flowers are still further complicated by the development of these supplementary outgrowths in the form of horns and tubes, either by cohesion of the margins, or by unequal growth and consequent depression of the centre, as before explained.

Pistillody of the Stamens.—Much the most interesting change, however, is that in which the stamens assume more or less of the condition of the carpels. The first case of the kind that fell under my own observation was nearly a quarter of a century ago, when I had the opportunity of inspecting a drawing and description of some flowers made by the Rev. G. E. Smith. His figures and his descriptions were so remarkable, that in my 'Vegetable Teratology' I confined myself to a mere mention of the case, and waited the time when, by the inspection of similar flowers, I might be able to form my own interpretation of the appearances presented. Mr. Smith's drawings bore every mark of accuracy; but I might well hesitate as to the correctness of the explanation given, when I read the following descriptions of the drawing:—"Stamen with anther sitting upon an imperfect petal and bearing a style; enlarged pollen with terminal style; anther bearing one long twisted style and stigma; stamen with pollen-cell proliferous, &c."

This was a description to whet the ardour of the humblest morphologist; but it was not till a short time ago, through the kindness of my friend Mr. Alfred Bennett, that I received from Miss Dowson, of Beccles, specimens evidently closely similar to those of the Rev. G. E. Smith, sufficiently so to vindicate the correctness of his drawings, and to supply an explanation of what was paradoxical in his descriptions. A comparison of the figures (Pl. XXXIX. figs. 24–32, which are copies from the drawings of the Rev. G. E. Smith), together with others taken from Miss Dowson's specimens by Mr. Worthington Smith and by myself, will show how close is the correspondence between the two sets of specimens (Pl. XXXIX. figs. 34–39, Pl. XL. figs. 1–3, and Pl. XLI. figs. 1–8).

No two of these flowers were exactly alike in all particulars; but there was so much general similarity between them in essential points, that it is not necessary to enter into details of particular flowers. The general appearances presented may therefore be briefly summarized as follows:—

Calyx normal. Corolla of a variable number of free, or nearly free, linear-oblong petals (Pl. XLI. figs. 1–3), the increase in number being obviously due to the fission or lateral chorisis of the original petals. This was seen by the fact of there being in some of the flowers, where the liberation of the petals was not complete, a short tube with five vascular bundles, each speedily dividing into two for the supply of the lateral subdivisions.

In the place of the normal stamens, but wholly detached from the corolla, were numerous free hypogynous pistillodic stamens, showing various degrees of transition between the conformation of the stamen and that of the carpel (Pl. XLI. figs. 4–7). The filamentary portion of these pistillodic stamens was, in some cases, but little changed; in other instances it was more or less dilated and leafy, and often crumpled or spirally twisted. In some the filament was dilated into an open carpel, destitute of ovules, but prolonged into a long style terminated by a stigma (Pl. XL. fig. 2). The ovarian portion was sometimes absent; and then the appearance was that of a style only (Pl. XL. fig. 3). In other cases the midrib of the filament or its central vascular bundle was thickened, and bore imperfect ovules (Pl. XXXIX. figs. 33–39). It is especially noteworthy that this placenta-like rib, while generally congenitally adherent to the leafy or carpellodic filament, was not unfrequently detached from it by chorisis, the significance of which fact will be further insisted on in the sequel.

In another series of these flowers the dilated filament was irregularly and pinnately lobed, the terminal lobe being incurved—a general occurrence, indeed, in the flowers in question. The uppermost of the lateral lobes very often bore marginal ovules, while the lower ones were infolded at the edges and prolonged into a long style and stigma (Pl. XL. fig. 1).

Here, then, we have a branched or divided carpellary leaf with some of its lobes open and others closed, both ovule-bearing. We have, in fact, the exact homologue of the so-called compound or branched stamen. The bearing of these facts on the nature of the free central placenta will be made apparent hereafter.

In the illustrations just cited it was the filamentary portion which was especially involved; but in another set of flowers the filament was unaffected or nearly so, and the changes were confined to the anther.

In the Rev. G. E. Smith's sketch the filaments were all normal, while in Miss Dowson's specimens they were usually more or less dilated. The changes observed in the antheral portion of the stamen, if stamen it can be called, were similar to those described in the case of the filament. Of anther, properly speaking, there was little or no trace, though the central placentary rib may be taken as the homologue of the connective, the latter prolonged occasionally into a style. In no case was I able to find any pollen at all. The ovules, indeed, occupy the situation of the pollen; but it could not be expected that there should be any transition between the pollen-cells and the ovules. Nor was I able to find, as I had hoped I might do, any trace of pollen in the ovules, as I have before seen in *Passiflora* and *Rosa*.

It should further be noted that the pistil in these flowers was quite normal *.

* Singular as these bisexual phyllomes are, they are relatively by no means unfrequent in certain plants, such as *Sempervivum tectorum*, *Cheiranthus cheiri*, and other plants mentioned in teratological records (see 'Vegetable Teratology,' p. 319). Even Conifers occasionally show similar phenomena. Thus, at the time of writing this paper, Mr. Syme, of the Elvaston Nurseries, sent me a catkin of *Cupressus Lawsoniana* in which the lower bracts were antheriferous and the upper ovuliferous; and, more than this, one of these bracts (Pl. XLI. figs. 9–11) bore on the outer surface, at the lower edge, an anther-cell, while on the inner face was a shortly stipitate ovule. Œrsted has recorded similar phenomena.

GYNÆCIUM.—*Phyllody*, or leafy condition of the *pistil*, is of not infrequent occurrence in the Primrose. Imperfect development is also not uncommon, in which case an imperfect tube or sheath, open at the top without trace of style, surrounds the placenta, the latter being in such cases usually elevated on a long stalk (Pl. XL. fig. 4). This is in accordance with the natural development of the carpel, save that it is arrested. In other cases, especially in the Chinese Primrose (*P. prænitens*), the carpels assume a petaloid guise, the entire pistil being completely open at the summit (Pl. XL. figs. 8 & 9).

Dialysis, or a lack of union of the carpels, is of frequent occurrence in the Primrose, there being in the simplest cases five open carpels, each with its separate style and stigma. In a double Polyanthus lately shown at the Royal Horticultural Society, the calyx was normal, the corolla in two rows, the first row normal, with stamens as usual. Within them was a second corolla, also provided with stamens. The gynæcium consisted of five more or less detached petaloid open carpels, each with a long style and stigma. One of these carpels was remarkable for having its margins divided into lobes; of these lobes the uppermost were prolonged into styles (Pl. XL. fig. 11), the lower bore imperfect ovules; so that the same carpellary leaf bore secondary carpels and ovules, exactly as in the case of the pistillodic stamens previously mentioned (Pl. XL. fig. 1).

PLACENTATION.—The free central placenta of Primulaceæ has naturally attracted much attention on the part of morphologists, some of whom have considered it to be of axial, some of foliar nature. The former view is that which is most generally adopted, though of late it has been contested by men of authority, on which account it may be well briefly to allude to the most important papers that have been published on the subject. A. de Saint-Hilaire * describes the placentas as originally connected with the interior of the style by a little thread, which is afterwards obliterated. Duchartre, in the paper before referred to, combats this view, and says that in the development of the ovary and the placenta "l'on remarque deux développements marchant parallèlement et simultanément; celui de la portion appendiculaire ou des parois de l'ovaire, du style et du stigmate, et celui de la portion centrale ou axile. Celle-ci pendant toute la durée de son développement reste libre et indépendante de la partie externe du verticille femelle; elle joue absolument le rôle d'un petit rameau végétant sous un abri protecteur, le seul rôle du reste qu'elle puisse jouer. D'abord entièrement homogène elle se laisse diviser plus tard en deux parties, l'une inférieure, qui donne naissance aux ovules et qui possède toute la structure de l'axe lui-même, l'autre supérieure et stérile uniquement celluleuse, dont le développement est, le plus souvent, très-borné, qui parfois s'accroît . . . et devient un petit cône logi dans la partie inférieure du canal stylaire."

Payer † entirely adopts the conclusions of Duchartre, as, indeed, do most modern observers.

A large number of teratological phenomena might be cited in favour of this view, such as the instance cited by Duchartre in which a flower-bud was observed at the apex of the placenta in *Cortusa Mathioli*. Other prolifications of a similar character have been

* Mémoire sur les plantes auxquelles on attribue un placenta central libre (1816).

† Organogénie Végétale, p. 611.

recorded by Marchand and others. Baillon * even mentions a species of *Lysimachia* in which the placenta was prolonged beyond the ovary in the form of a shoot bearing leaves, and which was cut off and struck as a cutting.

Alphonse de Candolle and many others have noticed the placenta giving off leaves instead of ovules.

In double Primroses it is not unusual to find the placenta bearing ovules at its lower part and one or more carpels above (Pl. XL. figs. 12–15)—a condition which has its parallel in the singular instance described by Mr. Berkeley in a species of *Dianthus* †. Such instances as those just alluded to support the view that the placenta is an axial structure; nor is that notion necessarily invalidated by the very common occurrence of free central, marginal, and parietal placentation, with every intermediate state, in the ovaries of double Primroses; for the presence of ovules, as of buds, is of itself no proof either of the foliar or of the axial structure of the organ from which they spring.

There are, however, many valid reasons for supposing the placenta to be of foliar origin: thus Van Tieghem ‡, who at one time considered the placenta of Primulaceæ to be the direct prolongation of the axis (Ann. Sc. Nat. 5e sér. 1868, t. ix. p. 211), is now satisfied that the vascular bundles of the placenta have their spiral vessels on the outer side, and that they are therefore appendicular. On the other hand, he admits that in cases of virescence or prolification, the axial system of the pedicel is abnormally prolonged into the cavity of the carpels. In this latter case the tracheæ are internal. The vascular bundles of the placenta then, instead of being independent of the carpels, are offshoots from them. A similar conclusion is arrived at with reference to *Theophrasia*.

In a note appended to p. 622 of his translation of Sachs's 'Lehrbuch,' M. Van Tieghem gives the following summary of his present views, which it is convenient to cite in this place.

" L'étude anatomique démontre que le pétale et l'étamine superposés (Primulaceæ), ne sont que les deux parties d'une seule et même feuille ramifiée, qui a subi une métamorphose héterogène et double appropriée à deux fonctions différentes. Mais, en outre, elle fait voir que la colonne placentaire est formée, non par le prolongement de l'axe floral au dessus de l'insertion des carpelles, comme on l'admet généralement, mais par des dépendances liguliformes des carpelles qui constituent la paroi de l'ovaire unies et soudées entre elles dans l'axe géométrique de la fleur comme les carpelles le sont eux-mêmes latéralement dans toute leur étendue. De sorte que les ovules sont ici, aussi, insérés en définitive sur la feuille carpellaire, et qu'ils ont par conséquent la valeur morphologique de lobes de feuille "§.

Al. Braun || held somewhat similar views to Van Tieghem's, and pointed out that many cases in which the placenta appears to be axial may be explained by the congenital detachment of the bases of the carpellary margins and their fusion one with another

* Baillon, 'Adansonia,' iii. p. 310.

† Gard. Chron. Sept. 1850, p. 612, and Veg. Terat. p. 268.

‡ Ann. Sc. Nat. 5e sér. t. xii. p. 329 (1871); 'Recherches sur la structure du pistil' etc. p. 91.

§ Trécul, however (Comptes Rendus, Oct. 23, 1876), contests Van Tieghem's views, and shows that in *Anagallis* the vessels of the placenta originate independently of and *before* those of the walls of the ovary. The parietal and placental vessels do not correspond in number; nor are they continuous with, but quite free from, those of the thalamus.

|| Analysis in Bull. Soc. Bot. France, Rev. Bibl. (1875) t. xxii. p. 63.

in a line continuous with the floral axis, although he admitted that in Primulaceæ there are grounds for supposing the placenta to be truly axial *.

The appearances presented by the double Primrose sent by Miss Dowson substantiate the view of Van Tieghem, that the placenta is derived from the carpellary leaf by chorisis (Pl. XXXIX. figs. 34–38). In the specimens in question the placentas are sometimes marginal, at other times parietal, the placenta in this latter case being homologous with the midrib of a carpellary leaf, and not unfrequently detached from it, sometimes slightly, at other times completely (Pl. XXXIX. figs. 37, 38). Double-flowered Primulaceæ in fact frequently furnish illustrations of free central, axile, marginal, and parietal placentation (Pl. XL. fig. 16). Moreover they show that in some cases the placenta, whatever its position, is a mere outgrowth from the carpellary leaf, capable of becoming completely detached from it, and in that case simulating an axis.

In a malformed Cowslip, a figure of which is given (Pl. XL. figs. 17–20), among other changes the pistil was broken up into its five carpels, each with its style and stigma. In the centre of the flower was a mass of threads or funicles, each surmounted by an imperfect ovule. Some of these threads evidently sprung from the inner surface of the carpels, others from the margins, while the majority were quite detached from the carpellary leaf.

In the normal flower this detachment must take place, if at all, at a very early period, and the placentary ribs of one carpel may become united to those of another, and so, at length, a free central placenta may be formed. If the axial appearance of the placenta and the five vascular bundles visible in it be cited as proof of its axial nature, it may be pointed out that five petioles, each with a single vascular bundle and united together, would give an appearance of an axis.

For my own part, I look on the alleged distinction of axial and appendicular organs as one of convention, desirable to be kept up for descriptive or classificatory purposes, but altogether of secondary importance from a morphological point of view. The occurrence of leaf-buds or flower-buds on the placenta, such as have been recorded in various monstrous Primulaceæ, therefore has not for me the same degree of significance that it has for those who look upon their presence as indicative of the axial nature of the organs bearing them. Leaf-buds, flower-buds, and roots may and do arise from leaf-organs or phyllomes, as they do from caulomes, and they cannot be looked on as absolutely characteristic of either †.

* In the female flower of an Alder (*Alnus*) sent to me by Mr. Stratton, among other changes, the ovules were borne on a stalk standing up free in the centre of a one-celled pistil, forming a free central placenta. It seemed probable that in this case the stalk was composed of the detached dissepiments of the ovaries.

† As I write I have before me a flower of *Calochortus* sent me by Mr. Burbidge, in which the filament of the stamen bears at its junction with the anther a well-marked bud (Pl. XL. fig. 21). These adventitious buds are sometimes veritable enations; at other times they are borne on stalks which are congenitally adherent to to the leaf-organ. See Planchon, "Quelques mots sur les inflorescences epiphylles," Mém. Acad. Stanisl. 1862, p. 403; Caspary, Schrift. phys.-œkon. Gesellsch. zu Königsberg, 1874. Still more germane to the subject now under consideration are those cases in which the placenta bears leafy ovules, as happens occasionally in Crucifers. In a species of *Triumfetta*, and in one of *Corchorus*, I have seen a similar arrangement, the latter case (Pl. XL. figs. 21–24) being particularly interesting from the position of the leafy ovules on the midribs of the carpels (parietal), not on the margins.

So far, then, as the nature of the placenta is concerned, we have two theories: according to the one it is essentially axial; according to the other it is foliar. Organogenetic evidence is strongly in favour of the axial view, though it is quite clear that, had it been practicable to observe the mode of development of the monstrous Primroses above described, the foliar nature of their placenta would have been proportionally as obvious as in the adult state.

The evidence derived from minute anatomy is conflicting; and it is doubtful whether so much importance should be attached to the position of the vascular bundles and of their constituent elements as Van Tieghem is disposed to attribute to them.

Comparative morphology is entirely in favour of the axial view; there is not, so far as I am aware, a single genus of Primulaceæ or of Myrsinaceæ where, under normal circumstances, the placenta is any thing else but "free central."

Teratology, as we have seen, affords support to either view, and lands us in this dilemma. Either we must say that any or all forms of placentation, foliar and axial, may occur in Primulaceæ—a conclusion to which morphologists would certainly demur, except as a monstrous condition; or we must admit that the evidence afforded by teratology is utterly worthless in deciding such cases, and that the appearances in question are, in fact, simply accidental and abnormal. To this latter conclusion equally strong objection may be taken. Extraordinary as these appearances sometimes are, they may generally be easily referred to ordinary morphological laws. If this be admitted, as it must surely be by any one who has paid any attention to the subject, then we are sent back to the morphological dilemma above mentioned.

As a provisional means of dealing with it, it may be suggested, as an hypothesis, that the stock from which Primulaceæ descended had parietal placentation, but that in course of time the placentas have become detached from the walls of the ovary, and fused together to form the free central placenta. Looked at in the light of this hypothesis, the monstrous flowers above alluded to, showing every gradation between carpellary and axial placentation, are mere reversions to an ancestral form.

For this hypothesis it must be admitted no evidence can be adduced beyond that of the monstrosities in question and the occasional presence of a little filamentous process (the *filet* of St.-Hilaire) connecting the placenta with the apex of the ovarian cavity—a process the existence of which is doubted by Duchartre, but which is nevertheless occasionally to be seen on making sections of young Primulaceous ovaries, and which is, on this hypothesis, to be explained as a rudiment of the process of chorisis, by which the former generations of Primroses changed their parietal for a free central placenta.

Ovules.—From the ordinary appearance of the placenta in Primulaceæ, and the position of the ovules upon it, it might well be supposed that the ovules or, rather, their outer coats were independent of the carpels, and direct outgrowths from an axial placenta, each ovule being the representative of a distinct leaf or phyllome. The cases recorded by Unger, Alphonse deCandolle, Brongniart, Marchand, Cramer, and others *,

* Vegetable Teratology, p. 263.

may almost all be alleged in support of this view. Nevertheless, when the evidence thus presented us is analyzed a little carefully, and correlated with the facts revealed to us by anatomy and development, it will be found that in most cases the facts related are not incompatible with the notion that the placenta is essentially an outgrowth from the carpellary leaf, and, by consequence, that the ovules, or their outer coats, are also derivatives from that source. Although the question, whether the ovular coat be a direct formation from the axis, or whether it originates from the carpellary leaf, may still be said to be undecided, yet the foliar character of the ovular coat will hardly now be contested. To the establishment of this point the investigations of monstrous Primroses by Brongniart and others * have mainly tended. It is not necessary to do more than recall these observations, because their accuracy has never been called in question. The illustrations now brought forward show clearly that the ovules of these particular Primroses are processes from the carpellary leaf, either marginal or detached by chorisis from its centre. This is in accordance with the views of Van Tieghem as cited in the extract previously quoted. The occurrence of secondary carpels on the placenta, mixed with the ovules, also confirms this view. In this latter case we have a branched or compound carpel, some of the lobes of which are developed as ovules, others as secondary carpels.

These remarks, of course, apply to the outer coat of the ovule, and not to the nucleus. None of the monstrous flowers of Primulaceæ that I have hitherto examined have given any clue to the nature of the nucleus.

SUMMARY.—Taking now a general review of Primulaceous structure, normal and abnormal, the facts cited seem to lead to the following conclusions:—

1. That the petals of most Primulaceæ (not in *Samolus* or *Androsace*) are late outgrowths from the receptacular tube outside the stamens, and posterior in development to them, but upraised with them by the upward growth of the so-called tube of the corolla.

2. That the placenta of existing Primroses is a direct prolongation of the receptacle or axis, without any connexion with the sides or apex of the carpels.

3. That the placenta in some (monstrous) flowers is an outgrowth, either from the margin or from the centre of the carpel, such outgrowth occasionally becoming wholly detached, the detached placentas, moreover, sometimes cohering one with another, and thus producing the appearance of a solid column directly prolonged from the receptacle. Such forms of placenta lead to the inference that the ancestral progenitors of Primulaceæ had parietal placentation, the monstrous forms being, on this view, looked on as reversions.

4. That both staminal and carpellary leaves may occasionally be divided or lobed, so that just as we meet with compound or divided stamens in Malvaceæ and other orders, so the carpels of some orders are the homologues of divided leaves, as first pointed out by Prof. Dickson.

5. That the ovular coat of Primulaceæ is essentially foliar, representing either the

* See specially Brongniart, Ann. Sc. Nat. 2e sér. t. i. 1834, p. 308, and Ann. Sc. Nat. 3e sér. t. xi. p. 20 (1844); Cramer, Bildungsabweichungen (1864).

blade (or dilated leaf-stalk) of an undivided leaf, or, in other cases, a lobe or process of the carpellary leaf, and not a direct production from the axis (assuming, for descriptive purposes only, a distinction between axis and appendage).

6. That the processes or lateral lobes of the carpellary leaf may be infolded, in some cases, so as to form secondary carpels.

Select Bibliography.

The following are among the principal works and memoirs relating to the structure of Primulaceous flowers, and which have been consulted in the preparation of these notes:—

Duchartre, "Observations sur l'organogénie de la fleur &c. chez les plantes à placenta central libre," Ann. Sc. Nat. 3e sér. tome ii. (1844) pp. 279. *Cortusa Mathioli*, "Flower on apex of free central placenta."

Brongniart, Ann. Sc. Nat. 2e sér. tome i. p. 308, t. ix., and 3e sér. tome ii. (1844) p. 20.

Babington, C. C., Ann. Nat. Hist. 1844, p. 464. *Primula vulgaris.* In place of the ovary a cup-shaped body, from the centre of which springs a cylindrical column, bearing a cup-like sheath, or imperfect ovary at the top, surrounding a conical placenta studded with ovules.

Alphonse de Candolle, Neue Denkschriften, Band v. p. 9. General phyllody of flower of *Primula auricula*, leafy condition of ovules, &c. *P. prænitens*, flowers within the ovary, &c.

Baron de Melicoq, Ann. Sc. Nat. t. x. 1846. Prolification of inflorescence, &c.

Unger, Act. Acad. Nat. Cur. 22, ii. (1850) p. 543, t. 5 & 6; Bot. Gazette, May 1851, p. 70. *Primula sinensis*, phyllody of the parts of the flower, &c.

Payer, Organog. p. 611, t. 153 (1857).

Masters. *Primula sinensis* (March 1859). Pistil entirely wanting; in place of it an umbel of about six rays, each bearing a small flower-bud.

Cramer, Bildungsabweichungen, p. 132 (1864).

Masters, Vegetable Teratology, 1869. In this volume a large number of references are given to various malformations recorded by various observers or by the author.

Cave, "Sur le placenta central libre des Primulacées" (analyzed in Bull. Soc. Bot. France, xvii. 1870, p. 110, Rev. Bibl.). The author supports the axial nature of the placenta on anatomical grounds. If, says M. Cave, the spiral vessels are on the inner side of the generating layer, the organ is axial, and *vice versâ*.

Faivre, Sur l'ovule et sa nature morphologique chez le *Primula sinensis*. Pamphlet, analyzed in the Bull. Soc. Bot. France, lxvii. (1870), Rev. Bibl. p. 90. The ovule is considered to be homologous with a leaf. the funicules = petiole, the ovular coat = the lamina. See also Bull. Soc. Bot. Fr. 1869, p. 127.

Clos, Essai de Tératologie Taxinomique (1871), p. 20. In this are cited the teratological records relating to the Primulaceæ, extracted from various publications issued since the date of Moquin-Tandon's classic work, 'Eléments de Tératologie Végétale' in 1841.

Pfeffer, "Zur Blüthenenttwickelung der Primulaceen," Pringsheim's Jahrbuch, viii. p. 194.

Van Tieghem, "Structure du pistil des Primulacées," &c., Ann. Sc. Nat. 5e sér. tome xii. (1871) p. 329.

J. L. de Lanessan, "Sur le développement des faisceaux fibro-vasculaires dans les organes floraux des Primula," Bull. Soc. Linn. Par. No. 4, Nov. 1874. Shows, with Trécul, that the fibro-vascular bundles are late formations in comparison with the cellular tubercles in which the several organs of the flower begin.

Braun, Verhandl. des bot. Vereins der Provinz Brandenburg, 1874, p. 45.

Celakovsky, Flora, 1874, p. 170; and Vergleichende Dartstellung der Placenten in den Fruchtknoten der Phanerogamen, 1875. Placenta of Primulaceæ considered to be axial.

Eichler, Blüthendiagramme (1875), p. 327. Considers that the outer row of stamens is abortive, the inner congenitally united with the petals. The placenta is considered axial, and the ovules foliar.

Morren, C., Bull. Acad. Roy. de Belgique, t. xix. No. 8, p. 539, c. tab.: *Primula prænitens*, virescence and phyllomorphy of flower. Bull. Acad. Roy. de Belgique, xix. p. 97, c. tab.: calycanthemy.

DESCRIPTION OF THE PLATES.

Plate XXXIX.

Figs. 1–9 *inclusive represent various Stages in the Development of the Flowers of* Primula japonica. The figures are all highly magnified.

Fig. 1. The young flower, seen from the side, with its bract *b*; *c*, the calyx; *st*, the staminal tubercles.

Fig. 2. Flower, seen from the top. The calyx is formed, and also the staminal tubercles, but no petals or pistils.

Fig. 3. View of a fragment of a flower, showing three sepals and two stamens, with indications of the petals, *p*, at their base.

Fig. 4. Side view of a flower rather further developed. The sepals are removed; the staminal tubercles, *st*, are shown, with the petals, *p*, and the commencement of the corolla-tube.

Fig. 5. Portion of a flower still further developed, seen from within, and showing three staminal tubercles and the commencement of three carpellary tubercles, *c*.

Fig. 6. Fragment of a flower in a further stage of development. Three carpels are shown free above, but congenitally coherent below; the placenta, *pl*, is already formed in the shape of a dome-shaped mass, studded towards the base with ovules, which develop from above downwards.

Fig. 7. Section of the young pistil of another flower, with the placenta, *pl*, not yet producing ovules, although the development of the pistil is further advanced than in the preceding.

Fig. 8. Pistil in a further stage of development, and nearly closed.

Fig. 9. Diagrammatic section of a flower with sepal (*s*), stamen (*st*), petal (*p*), carpel (*c*), and placenta (*pl*), all formed, and the upraising of the so-called corolla-tube just begun.

Figs. 10–23. *Illustrations of Chorisis and of Enation in the petals and stamens of* Primula vulgaris *etc.* All slightly enlarged.

Fig. 10. Lateral chorisis of the petals; the venation at the base shows that each of the original vascular bundles destined for the petals is split into two divisions.

Figs. 11–16. Enation; various outgrowths from the petals. 16. Section showing plan of arrangement of parts in fig. 15.

Fig. 17. Supernumerary petals in *Primula Auricula*. Fig. 18. Sectional plan of the same.

Fig. 19. Stamen of *Primula vulgaris*, with a petal growing from it, and two supernumerary petaloid outgrowths, developed in the order shown by the numerals (I. II. III. IV.) in fig. 20.

Fig. 21. Petal of *Primula vulgaris*, with petaloid anther. Fig. 21 *a*. Similar anther detached.

Fig. 22. Petaloid stamen of a variety of Polyanthus, "the Nigger," developing from either side, by enation, secondary petaloid laminæ in the order in which they are numbered (I. to V.). Fig. 23. Plan of the same, the Roman numerals corresponding.

Figs. 24–32. *Copied from drawings by the Rev. G. E. Smith of monstrous flowers of* Primula vulgaris.

Figs. 24, 25. Flowers, seen from the side: nat. size.

Fig. 26. Flower, natural size; sepals and petals turned down to show the hypogynous pistillodic stamens and the normal pistil.

Fig. 27. Normal pistil, with hypogynous petal, attached to which is a pistillodic stamen: magnified.

Fig. 28. Pistillodic stamen from 26, magnified, showing a filament, a dilated anther bearing rudimentary ovules in the centre and at the margins and with a terminal style.

Fig. 29. Pistillodic stamen with ovules, and three secondary carpels with styles.

Fig. 30. Back view of the same, the styles cut across: magnified.

Fig. 31. Filament with pistillodic anther, from the side: the margins bear ovules; and the apex terminates in a style.

Fig. 32. Filament with pistillodic anther, with abortive ovules and terminal style.

Figs. 33–38. *Pistillodic Stamens from* Primula vulgaris, *taken from the flowers shown in* Plate XLI.: all slightly magnified.

Fig. 33. Pistillodic stamen, with apex infolded, and with central placentary rib bearing ovules. In other cases this rib was quite detached.

Fig. 34. Section of preceding.

Fig. 35. Similar stamen to 33, with detached filamentous outgrowth.

Fig. 36. Another specimen, placental rib quite detached except at the base.

Fig 37. Section at upper portion.

Fig. 38. Section at lower portion.

Plate XL.

Figs. 1–3. Primula vulgaris, *from Miss Dowson's specimens* (magnified).

Fig. 1. Pistillodic stamen irregularly pinnately lobed, terminal lobe infolded, lateral lobes some destitute of ovules, others ovuliferous on one or both margins; lowermost lobe infolded so as to become a secondary carpel, with ovules on its margin, and its apex prolonged into a style; from the centre emerges a placentary rib bearing an imperfect ovule.

Fig. 2. Pistillodic stamen, in the form of an open carpel, with ovary, style, and spatulate stigma, but destitute of ovules.

Fig. 3. Pistillodic stamen represented by a spiral style only.

Figs. 4–16 *show Leafy or Petal-like Condition of Pistil etc.*

Fig. 4. Leafy pistil laid open, taken from a virescent Primrose, magnified. The pistil, owing to arrest of development, was in the shape of a tube open at the top. The placenta is seen above the orifice of the tube of the pistil raised on a long stalk, and covered by imperfect stalked ovules.

Fig. 5. Section of upper part of placenta of the same.

Figs. 6 and 7. Abortive ovules from the same.

Fig. 8. Petalodic pistil of *P. vulgaris* open at the top, and cut down the side to show the placenta: magnified.

Fig. 9. Similar pistil from *P. prænitens.* The free edge of the petaloid carpels is here fringed; the surface bears a few imperfect ovules (parietal placentation) in addition to the free central placenta.

Fig. 10. Extremity of placenta from the same flower, enlarged, and with some of the ovules removed to show the apex of the placenta giving off thickened funiculi destitute of ovules.

Fig. 11. Open carpel of Polyanthus, showing carpel lobed at the sides—the lobes being, some of them ovuliferous (*ov*), others prolonged into styles, as is also the apex: magnified.

Fig. 12. Placenta bearing ovules (one of which is detached and enlarged at fig. 13), and a carpel with a long style and spatulate stigma.

Fig. 14. Placenta with ovules removed to show the carpel.

Fig. 15. Base of carpel.

Fig. 16. Pistil of *Primula prænitens,* showing marginal and free central placentation, and dialysis of four styles: magnified.

Figs. 17–20. *Virescent Cowslips etc.*

Fig. 17. Flower of Cowslip, *Primula veris.* Petals virescent, stamens imperfectly developed, pistil dialyzed, ovules represented by thread-like funicles bearing abortive ovules.

Fig. 18. Section of a similar flower.

Fig. 19. Diagram showing the dialysis of the carpellary leaves and the position of the abortive ovules in figs. 17 and 18.

Fig. 20. Section of normal ovary with free central placenta.

Figs. 21, 22. *Calochortus,* sp.

Figs. 21, 22. Front and back views of a petaloid stamen of *Calorchortus,* sp. The anther is petaloid; and at the junction with the filament is a bud, three leaves of which are petaloid, unfolded, and spreading; the others, smaller, are still undeveloped. (Drawn by Mr. Burbidge.)

Figs. 23, 24. *Corchorus,* sp.

Fig. 23. Flower of *Corchorus* with five sepals, the petals and stamens removed to show the stalked ovary.

Fig. 24. Ovary laid open, to show leafy ovules on dorsal and ventral sutures of carpels.

PLATE XLI.

Figs. 1–8. Primula vulgaris *with pistillodic stamens* (*Miss Dowson*), *drawn by W. G. Smith, Esq., F.L.S.* All magnified.

Fig. 1 shows a longitudinal section, with numerous hypogynous pistillodic stamens, the filaments leafy or petaloid, the anthers ovuliferous in the middle, and the connectives prolonged into a two-lobed incurved petaloid lobe. The central pistil is normal, with a long style.

Figs. 2–3. Sections of similar flowers. The apices and sometimes the lateral lobes of the pistillodic stamens are prolonged into styles terminated by stigmas.

Fig. 4. Pistillodic stamen from one of the above flowers. Filament dilated; anther open, ovuliferous in the centre; connective petaloid, two-lobed.

Figs. 5–7. Similar stamens to fig. 4.

Fig. 8. Pistillodic stamen reduced to a style with terminal spatulate stigma.

Figs. 9–11. *Cupressus Lawsoniana.*

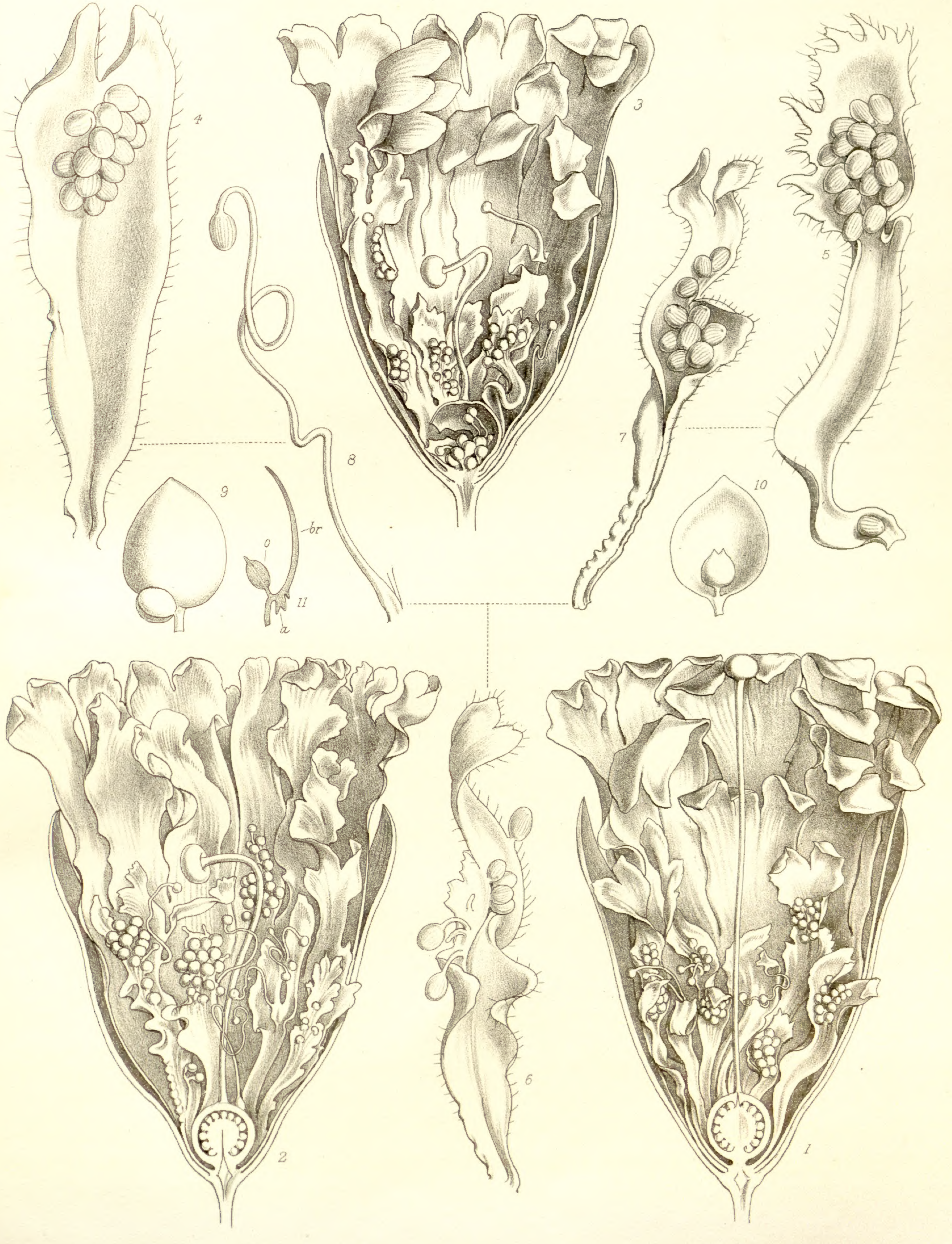
Fig. 9. Back or outer surface of bract with anther-lobe at lower edge.

Fig. 10. Front of the same bract, with a single ovule raised on a short stipes. The usual ovuliferous scale is abortive, so that the ovule appears to arise directly from the base of the bract.

Fig. 11. Longitudinal section through the bract, to show the position of the anther and of the ovule: *a,* anther; *br,* bract; *o,* ovule.

J.N.Fitch lith. FLORAL CONFORMATION OF PRIMULACEÆ. Fitch imp.

J.N.Fitch lith. FLORAL CONFORMATION OF PRIMULACEÆ, *etc.* Fitch imp.



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FLORAL CONFORMATION OF PRIMULACEÆ, *etc.*

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